Vol. 12, No. 12
June 30, 1987

Energy Research Abstracts

Abstracts 24385-26411

Office of Scientific & Technical Information
UNITED STATES DEPARTMENT OF ENERGY

CURRENT INFORMATION ON ENERGY

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The publications described below and access to ITIS/OARS are available to Department of Energy and contractor components from the Office of Scientific and Technical Information, U. S. Department of Energy, P. O. Box 62, Oak Ridge, TN 37831/Telephone (615) 576-1301; FTS 626-1301.

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***Energy from Biomass (EFB)*–PB87-900600.** Biomass production, conversion, and utilization for energy.

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***Heavy-Ion Reactions (HIR)*–PB87-900500.** Heavy-ion ($A > 4$) reactions.

***Laser Research (LAR)*–PB87-901100.** Laser research and development, excluding applications.

***Nuclear Fuel Cycle (NFC)*–PB87-913400.** Both front and back ends of the nuclear fuel cycle.

***Nuclear Reactor Safety (NRS)*–PB87-913500.** Accident analysis, safety systems, radiation protection, decommissioning and dismantling, and security measures.

***Radioactive Waste Management (RWM)*–PB87-902900.** Management aspects of transport and storage, waste processing, waste disposal, waste storage, radioactive effluents, and shipping containers.

***Solar Thermal Energy Technology (STT)*–PB87-901200.** Research and development of efficient and reliable solar thermal conversion systems.

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***Unconventional Petroleum (UCP)*–PB87-901300.** Secondary and tertiary recovery of petroleum and oil shales and tar sands.

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The Office of Scientific and Technical Information (OSTI) cooperates in the publication of international abstract journals with the following: (1) International Atomic Energy Agency, International Nuclear Information System, Vienna, Austria, for *Atomindex;* (2) International Energy Agency, Biomass Conversion Technical Information Service, Dublin, Ireland, for *Biomass Abstracts;* and (3) International Energy Agency, IEA Coal Research, London, England, for *Coal Abstracts.* In each case, the cognizant foreign agency provides the non-U. S. information to OSTI for inclusion in the Energy Data Base; in turn, OSTI provides the U. S. information for input into the respective journal.

Atomindex

A semimonthly abstract journal providing worldwide coverage of information on nuclear science and technology. *Atomindex* is available by subscription from Bernan Associates—UNIPUB, 10033-F King Highway, Lanham, MD 20706. The cost of an annual subscription, 24 semimonthly issues and semiannual and annual cumulative indexes, is $355.

Biomass Abstracts

A bimonthly abstract journal with comprehensive coverage of information on the conversion of biomass to energy. *Biomass Abstracts* is available free to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Biomass Abstracts* from Biomass Conversion Technical Information Service, Institute for Industrial Research and Standards, Ballymun Road, Dublin 9, Ireland, for 60 IR pounds per year for participating countries and 90 IR pounds per year for nonparticipating countries. Make checks payable to the Institute.

Coal Abstracts

A monthly abstract journal providing comprehensive worldwide coverage of information in the field of coal science and technology. *Coal Abstracts* is available to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Coal Abstracts* from IEA Coal Research, Technical Information Service, 14-15 Lower Grosvenor Place, London SW1W 0EX, England, for 110 pounds sterling per year.

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ENERGY RESEARCH ABSTRACTS

ABOUT THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

The Office of Scientific and Technical Information (OSTI) in Oak Ridge, Tennessee, has been the national center for scientific and technical information for the Department of Energy (DOE) and its predecessor agencies since 1946. In developing and managing DOE's technical information program, OSTI places under bibliographic control not only DOE-originated information but also worldwide literature on scientific and technical advances in the energy field and announces the source and availability of this information. Although the literature of science is emphasized, coverage extends to DOE programmatic, socioeconomic, environmental, legislative/regulatory, energy analysis, and policy-related areas. To accomplish the mission of furnishing centralized support for Departmental elements in managing their scientific and technical information, OSTI builds and maintains computerized data bases and disseminates information via computerized retrieval systems and announcement publications such as abstract journals, bibliographies, and bulletins. Direct access to OSTI's Energy Data Base (EDB) and Nuclear Science Abstracts Data Base (NSA) is available to the U. S. scientific community through commercial on-line retrieval systems. Access to these data bases from outside the United States is available only through formal exchange agreements. The current-year EDB records, DOE Research-In-Progress, and various other specialized DOE data bases are available to DOE offices and contractors and other government agencies through the OSTI Automated Retrieval System (OARS), which is a major component of the Integrated Technical Information System (ITIS). In addition to providing access to the OSTI on-line systems, ITIS serves as a gateway to other government and commercial systems and provides information merging for customized information products. The Office of Scientific and Technical Information has developed systems to record and communicate energy-related research-in-progress information, to track research report deliverables from DOE contractors, to test and make available DOE-funded computer software programs with scientific and management applications, and to produce special publications in support of DOE program offices. To manage DOE's technical information resources effectively, OSTI's program is one of continual development and evaluation of new information products, systems, and technologies.

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Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

ERA is comprehensive in its subject scope, encompassing the DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

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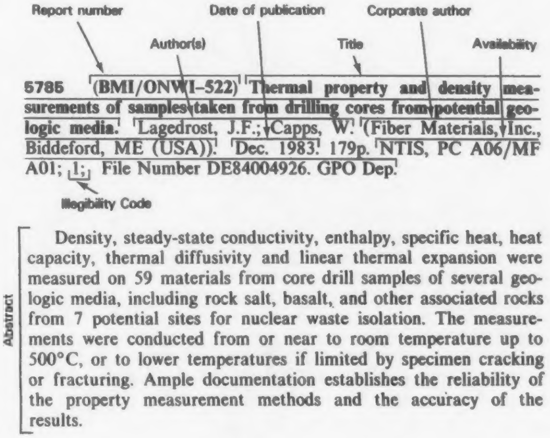
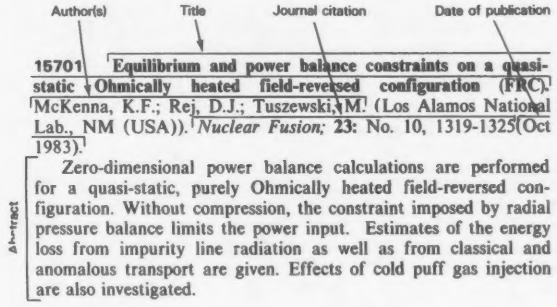
The principal elements of abstract entries for a typical research and development report and a typical technical journal article are illustrated below.



5785 (BMI/ONWI-522) **Thermal property and density measurements of samples taken from drilling cores from potential geologic media.** Lagedrost, J.F.; Capps, W. (Fiber Materials, Inc., Biddeford, ME (USA)). Dec. 1983. 179p. NTIS, PC A06/MF A01; 1; File Number DE84004926. GPO Dep.

Density, steady-state conductivity, enthalpy, specific heat, heat capacity, thermal diffusivity and linear thermal expansion were measured on 59 materials from core drill samples of several geologic media, including rock salt, basalt, and other associated rocks from 7 potential sites for nuclear waste isolation. The measurements were conducted from or near to room temperature up to 500°C, or to lower temperatures if limited by specimen cracking or fracturing. Ample documentation establishes the reliability of the property measurement methods and the accuracy of the results.



15701 Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC). McKenna, K.F.; Rej, D.J.; Tuszewski, M. (Los Alamos National Lab., NM (USA)). *Nuclear Fusion;* **23:** No. 10, 1319-1325(Oct 1983).

Zero-dimensional power balance calculations are performed for a quasi-static, purely Ohmically heated field-reversed configuration. Without compression, the constraint imposed by radial pressure balance limits the power input. Estimates of the energy loss from impurity line radiation as well as from classical and anomalous transport are given. Effects of cold puff gas injection are also investigated.

INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA)*. Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

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Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

5785 (BMI/ONWI-522) Thermal property and density measurements of samples taken from drilling cores from potential geologic media. Lagedrost, J.F.; Capps, W. **(Fiber Materials, Inc., Biddeford, ME (USA)).** Dec. 1983. 179p. NTIS File Number DE84004926. GPO Dep.

is indexed as:

Fiber Materials, Inc., Biddeford, ME (USA)

• Personal Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Capps, W., *See* Lagedrost, J. F.
Lagedrost, J.F., Thermal property and density measurements of samples taken from drilling cores from potential geologic media, 9:5785 (R;US)
McKenna, K.F., Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC), 9:15701 (J;US)
Rej, D.J., *See* McKenna, K.F.
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• Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

SALT DEPOSITS
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REVERSED-FIELD PINCH
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• Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

AC06-76RL01830	**Fiber Materials, Inc., Biddeford, ME (USA)**	
	9:5785	BMI/ONWI-522

• Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. Patents and conference papers are indexed here as a matter of convenience. When a report is supplied under a File Number, that number is included in the availability statement. A file number-report number correlation is included for convenience.

BMI/ONWI-522	9:5785	NTIS, PC A09/MF A01. File Number DE84004926, Distribution Category MN-70

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Commack, NY

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SUBJECT CONTENTS (ALPHABETICAL LISTING)

Six-digit subject category numbers are used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's computerized bibliographic information system. The six-digit category numbers are utilized as if they were three pairs of two-digit numbers, the first two pairs being used to arrange the abstract content of *Energy Research Abstracts*. The following listing includes the totality of the 40 first-level and 289 second-level subject categories used. Because each issue of *ERA* announces only those documents becoming available during a semimonthly period, some subject categories may not be represented in every issue. The complete subject category scheme with scope definitions and limitations is available as DOE/TIC-4584-R6 from NTIS for $9.50.

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ENERGY RESEARCH ABSTRACTS

01 COAL AND COAL PRODUCTS

24385 **Proceedings of the 3rd annual Pittsburgh coal conference.** Greensburg, PA; MEMS (1986). 973p. (CONF-860948—). MEMS, P.O. Box 270, Greensburg, PA 15601.

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

This book presents the papers given at a conference on coal. Topics considered at the conference included coal beneficiation, physical cleaning methods, chemical cleaning methods, environmental aspects of coal utilization, flue gas clean-up, project financing of new coal technology, coal reserves and characterization, coal transport, materials handling, storage, the production of gaseous and liquid fuels from coal, marketing, surface mining, the fundamentals of coal conversion, the combustion of coal slurry fuels, fluidized-bed combustion, advanced combustor technology, and coal utilization in transportation.

24386 **Newer coal technologies: Implications for energy and development policies in Asia and the Pacific.** Siddiqi, T.A.; Shihua, S. (eds.). Oxford, England; Pergamon Journals Ltd. (1986). 369p. (DOE/FE/60740—T1). Pergamon Journals Limited, Headington Hill Hall, Oxford OX3 OBW, UK. File Number TI87007749. Contract FG01-85FE60740.

The papers presented at the conference have been revised and shortened to meet the editorial requirements of "Energy - The International Journal." This hardcover edition is published by Pergamon Press. The first part contains overviews of coal-related policies in most of the major coal-producing and -consuming countries of the region. The later papers in the "Special Issue" have been grouped together under particular technologies or economic and environmental concerns. A few of the papers deal with international co-operation in developing coal and alternate energy technologies. It is our hope that we have provided a comprehensive overview of the present and future plans for coal use in the region, as well as of the technologies that are likely to have the most impact in changing the role of coal in the energy systems of the region. The interest and enthusiasm of friends and colleagues at the Ministry of Coal Industry, People's Republic of China, provided a major motivation for organizing the conference. The US Department of Energy, through its Office of Fossil Energy, provided financial support as well as technical expertise. Papers have been entered individually into EDB and ERA.

0103 Preparation

REFER ALSO TO CITATION(S) 24445, 24463, 24464, 24465

24387 **(DOE/PC/42302—T5) Use of surfactants in fine coal dewatering: Volume 1.** Gala, H.B.; Venkatadri, R.; Chiang, S.H. (Pittsburgh Univ., PA (USA). Dept. of Chemical and Petroleum Engineering). May 1986. Contract AC22-81PC42302. 149p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87006831.

The moisture in coal prior to its utilization is undesirable. The removal of moisture from fine coal (less than 500 microns in size) by filtration and thermal drying contributes heavily to the cost of the clean coal. As an alternative to thermal drying, the use of surfactants in vacuum filtration was investigated. The effect of cationic (dodecyl pyridinium chloride, Arosurf MG 83A), anionic (Aerosol-OT) and non-ionic (Triton X-114 and Triton X-100) surfactants on the filtration and dewatering characteristics of -32 mesh Pittsburgh Seam-Bruceton Mine coal was investigated by conducting adsorption, dynamic and equilibrium experiments at various surfactant concentrations. The surfactant concentration was monitored by measuring the surface tension of the aqueous solution. The adsorption isotherm of the surfactants exhibited three different region characteristic of a bilayer formation. A model for the adsorption isotherm, incorporating the orientation of the surfactant molecules at the surface of the coal particles was proposed, based on which the surface area of the coal was found to be 1000 to 2500 m^2/kg. The observed complex behavior of the moisture content versus the surfactant concentration curve was also consistent with the proposed model. An improvement in the dewatering characteristics was observed whenever the surfactant adsorption made the coal surface hydrophobic. The Darcy's equations for the flow of two phases through a porous medium predicted th dewatering curves for the filter cakes formed with thee surfactant solution coal slurry reasonably well. The relative permeability of the filtrate through the filter cake was calculated using the capillary pressure desaturation data obtained from the equilibrium experiments. 75 refs., 39 figs., 14 tabs.

24388 **(DOE/PC/81210—T14) Development and demonstration of a static tube flotation system for producing super-clean coal: 6th quarterly technical progress report.** Yang, D.C. (Michigan Technological Univ., Houghton (USA). Inst. of Materials Processing). 15 Apr 1987. Contract AC22-85PC81210. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008057.

Research continued during the quarter to optimize the static tube flotation conditions and test various flotation circuit configurations using the two selected coals - Pittsburgh and Lower Kittanning. A clean coal of <2% ash can be produced with >80% Btu recovery in one-stage tube flotation for both coals provided the mineral matter is sufficiently liberated. However, a two-stage process was adopted with the purpose of removing final products at the coarsest possible size and thereby reducing the grind cost. Because of the leaking problem of the DRAIS Perl Mill, a batch regrind procedure was employed to test two different flowsheets. Super-clean coal products containing 0.5 to 0.7% ash from the Lower Kittanning seam coal were produced at the weight recovery ranging from 60 to 79%. It is evident that more clean coal can be produced in a two-stage circuit than that of one-stage flotation. Further laboratory tests will be conducted in a continuous close-circuit setup as soon as the defective parts of the regrind mill are replaced. Another major thrust of the period was studying the effect on clean coal quality and yield of the optimum flotation dispersion concept. Although the advance in flotation chemistry is independent of machine design and operation, combining both of these new developments into one has resulted in added advantages. 9 figs., 4 tabs.

24389 **Enhanced magnetic separation of pyrite from coal after microwave heating.** Bluhm, D.D.; Fanslow, G.E.; Nelson, S.O. (Ames Lab., IA). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics;* MAG-22. No. 6, 1887-1890(Nov 1986).

The objective of this research was to improve the magnetic separation of coal and pyrite by enhancing the magnetic susceptibility of pyrite in run-of-mine coal through the use of selective dielectric heating. Separation of pyrite from coal would be facilitated by changing a portion of each pyrite particle to a more magnetic form. Studies included the measurement of the dielectric properties of different coal fractions at frequencies ranging from 1 MHz to 12 GHz. These values were then used to calculate the theoretical heating expected in these materials and their mixtures at 2.45 GHz. The experimental treatment showed general agreement between theoretical and experimental heating and that it is possible to heat pyrite in coal selectively. Data indicated an increase in the apparent magnetic susceptibility of dielectrically heated pyrite samples that was roughly proportional to the time and power of treatment. Magnetic separation tests were conducted on untreated and heated coal samples. Dielectric heating produced more magnetic material in the samples, increased the magnetic susceptibility and slightly improved magnetic separations.

24390 **Conditioning of carbonaceous material prior to physical beneficiation.** Warzinski, R.P.; Ruether, J.A. US Patent Application 6-863,650. 15 May 1986. 18p. DE87007252 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007252.

A carbonaceous material such as coal is conditioned by contact with a supercritical fluid prior to physical beneficiation. The solid feed material is contacted with an organic supercritical fluid such as cyclohexane or methanol at temperatures slightly above the critical temperature and pressures of 1 to 4 times the critical pressure. A minor solute fraction is extracted into critical phase and separated from the solid residuum. The residuum is then processed by physical separation such as by froth flotation or specific gravity separation to recover a substantial fraction thereof with reduced ash content. The solute in supercritical phase can be released by pressure reduction and recombined with the low-ash, carbonaceous material.

24391 **Fine grinding of coal with a stirred ball mill: The effect of process variables and chemical additives.** Lai, R.W.; Batchelder, R.F.; Wen, W.W. (DOE Pittsburgh Energy Technology Center, Pittsburgh, PA). pp 218-235 of Proceedings of the 11th annual powder and bulk solids conference and exhibition. Des Plaines, IL; Cahners Exposition Group (1986). (CONF-8605168—).

From 11. annual powder and bulk solids conference/exhibition: powder and bulk solids handling and processing; Rosemont, IL, USA (13 May 1986).

Stirred ball mill grinding of an eastern U.S. coal has been studied to determine the effects of pH, dispersant addition, and percent solids on the grinding efficiency. The results indicate that slurry pH, slurry viscosity, and solids concentration are important factors that affect the size reduction efficiency. Microscopic studies were employed to investigate the morphology, shape factor, and fracture of the ground products. It was concluded that the mechanism of size reduction in a stirred ball mill (at 43% solids range) is mainly attributable to the brittle fracture and propagation of stress-activated flaws during the impact and collision of coal with steel balls. Electrokinetics study revealed that grinding in the presence of an organic dispersant in an acid pH results in a change in the surface charges of coal and mineral matter in opposite directions.

24392 **Fractal dimension analysis of selective agglomeration of ultrafine coal.** Li, C.C.; Batchelder, F.; Wen, W.W. (Univ. of Pittsburgh, Pittsburgh, PA). pp 318-326 of Proceedings of the 11th annual powder and bulk solids conference and exhibition. Des Plaines, IL; Cahners Exposition Group (1986). (CONF-8605168—).

From 11. annual powder and bulk solids conference/exhibition: powder and bulk solids handling and processing; Rosemont, IL, USA (13 May 1986).

This paper presents a pilot study of fractal dimension analysis of agglomerates of ultrafine coal when fuel is used as the agglomerant. Samples were prepared for various oil concentrations, and individual agglomerate images were semiautomatically analyzed on a Zeiss IBAS system to obtain their mean fractal dimension, which decreases as the agglomerant concentration is increased. The study of this surface characteristic of coal agglomerates will provide valuable information for developing selective agglomeration as an advanced coal-beneficiation process.

0104 Processing

REFER ALSO TO CITATION(S) 24457, 24477, 24600, 25344

24393 **(DOE/ER/13217—3) Promoter modifications of catalytic activity and selectivity: Final report for period April 1, 1982-September 30, 1986.** Falconer, J.L. (Colorado Univ., Boulder (USA). Dept. of Chemical Engineering). 21 Jan 1987. Contract FG02-84ER13217. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007539.

The interaction of alkali promoters with supported nickel catalysts and the effects of alkali on CO and CO_2 hydrogenation were studied. Differential reactor studies, temperature-programmed desorption and reaction (TPD, TPR) with mass spectrometric detection, isotope labeling, static chemisorption, and x-ray photoelectron spectroscopy were used. The studies found that the alkali promoters significantly modify the activity and selectivity of supported nickel, and these modifications depend strongly on the support. Nickel catalysts with a range of nickel loadings and a range of potassium loadings were studied on SiO_2, Al_2O_3, TiO_2, and SiO_2-Al_2O_3 supports. Nickel powders were also used to separate the effect of the support. Two reaction sites were identified on Ni/Al_2O_3 catalysts and these sites were found to be significantly influenced by weight loading and promoter concentration. For SiO_2- and Al_2O_3-supported catalysts the K/Ni ratio was shown to not be a valid measure of promoter concentration on the active surface. The effect of alkali was studied as a function of the support, of K/Ni and K/support ratios, and of reduction temperature for Ni/TiO_2 catalysts. On Ni/SiO_2 the effects on the individual reaction steps were also measured and both carbon and carbon hydrogenation were dramatically slowed by potassium. Both CO and CO_2 hydrogenation are found to follow similar mechanisms, and good agreement was obtained between reaction on promoted nickel powders and studies by others on promoted single crystal surfaces.

24394 **(DOE/FE/60177—2305-Vol.2) Western Research Institute: Publications and presentations: Volume 2, final report, April 1983-September 1986.** Marchant, L.C. (ed.). (Western Research Inst., Laramie, WY (USA)). Dec 1986. Contract FC21-83FE60177. 53p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87008496.

Volume 2 of the final report for Cooperative Agreement FC21-83FE60177 lists the publications and presentations by Western Research Institute (WRI) researchers under that agreement. Entries in this list represent the four major US Department of Energy (DOE) programs included in that agreement - oil shale, tar sand, underground coal gasification (UCG), and advanced process technology (APT). Documents and presentations for WRI asphalt research, which is closely related to the four major programs, are also included. Most of the documents and presentations are milestone deliverable reports under the WRI-DOE cooperative agreement. The remainder are directly related publications and professional presentations that were prepared with the approval of DOE.

24395 **(DOE/FE/60177—2308) Investigation of tar sand and heavy oil deposits of Utah for underground coal gasification applications.** Trudell, L.G. (Western Research Inst., Laramie, WY (USA)). Dec 1985. Contract FC21-83FE60177. 44p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008443.

A literature review was conducted to determine spatial and geological relationships between Utah's tar sand or heavy oil deposits and coal deposits, and to evaluate these relationships in terms of suitability for underground coal gasification (UCG) applications. The investigation was undertaken as part of a Department of Energy-sponsored project to find new uses for UCG technology by utilizing process heat or combustible gases from UCG in thermal recovery of oil from unconventional sources. Fifteen of Utah's tar sand or heavy oil deposits are located within 5 miles of suitable coal deposits, which is the maximum distance considered economically practical for transport of UCG gases. Six of these deposits may be suitable for on-site development, where UCG could be conducted in coal beds directly under the oil reservoirs. Substantial portions of four major tar sand or heavy oil deposits are included in the resources suitable for UCG applications, i.e., Sunnyside, Asphalt Ridge, Ashphalt Ridge Northwest, and Raven Ridge. However, total resources cannot be calculated directly from published data. 31 refs., 9 figs., 2 tabs.

24396 (DOE/MC/22059—2306) Entrained flow gasification at elevated pressure: Quarterly technical progress report No. 8 for the period 1 December 1986 to 28 February 1987. Hedman, P.O.; Smoot, L.D. (USDOE Morgantown Energy Technology, Center, WV. Coal Projects Management Div.; Brigham Young Univ., Provo, UT (USA). Combustion Lab.). 31 Mar 1987. Contract AC21-85MC22059. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007856.

The three main tasks of this study are: (1) entrained coal gasification measurements, which include elevated pressure tests of three coal types, investigation of injector design, cold-flow measurements in simulated gasifier flows, and investigation of advanced optical diagnostic techniques that could be applied to gasification measurements; (2) improvement of the computer code for gasification processes, including improvement of physical submodels and numerical methods, and comparison of model predictions with experimental results for code validation; and (3) application of results to industrial and METC needs through technical seminars, expansion of a detailed data book, and distribution of the code to other users, especially METC. During this quarter, all of the experimental tests were completed. Chemical analysis of the samples taken was continued, analysis of the gasification data was continued, and preparation of the final report was initiated. Modeling work was near completion. 23 refs., 1 tab.

24397 (DOE/METC—86/0243) Physical gas stream cleanup: Technology status report. (USDOE Morgantown Energy Technology Center, WV). Apr 1986. 46p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86006589.

This report is a summary of the status of particulate control technologies for use at high temperatures and high pressures. The technologies are being developed under the Physical Gas Stream Cleanup Program that is administered by the US Department of Energy, Morgantown Energy Technology Center. The intended uses of the particulate control technologies are to protect components in advanced coal systems, such as integrated gasification combined cycles, pressurized fluidized-bed combustion combined cycles, gasification molten carbonate fuel cells, and direct coal-fueled turbines. The use of particulate control technologies for these advanced energy conversion systems requires separation and collection of particles at temperatures in excess of 1000°F and at pressures in excess of 7 atmospheres. These temperature and pressure regimes represent a drastic departure from those of conventional technologies. The Physical Gas Stream Cleanup Program seeks to establish a technical and economic data base that will demonstrate the feasibility of high-temperature, high-pressure particulate control. Particulate control concepts and their corresponding research and development projects are described in this report. These projects include subpilot-scale tests of an electrostatic precipitator, a ceramic cross-flow filter, and a screenless granular-bed filter on a 30-inch diameter pressurized fluidized-bed combustor. Bench-scale tests will also be conducted using a ceramic cross-flow filter, a ceramic bag filter, and an electrostatic precipitator on a 6-inch diameter fluidized-bed gasifier. Additional research involves laboratory evaluation of acoustic agglomeration, turbulence characterization and suppression in cyclones and characterization of ceramic fabrics for bag filters. Each project and significant accomplishments in FY 85 are described. 14 refs., 25 figs., 5 tabs.

24398 (DOE/PC/50031—T5) Development of a solid/liquid/gas phase fraction meter: Final report. Bernatowicz, H.; Gansmiller, D.; Wolff, S. (Science Applications International Corp., Sunnyvale, CA (USA)). 25 Feb 1987. Contract AC22-82PC50031. 139p. NTIS, PC A07/MF A01; GPO Dep. File Number DE87006449.

A non-intrusive phase fraction meter was developed for use at the preheater exit of the Solvent Refined Coal facility in Wilsonville, Alabama. The objective was to develop instrumentation that could continuously monitor in real-time the ratio of solids to gas to liquid in the process stream. The gauge utilized nuclear interrogation techniques to perform the measurement. The project was performed in three phases; the goals for each phase are: (1) Perform sensitivity studies to establish the ultimate accuracy of various measurement techniques and determine the effects of unknown variations in the process stream on the instrument response. (2) Based on the results of Phase I, design and fabricate a prototype gauge along with control and analysis software. The components were integrated and the instrument calibrated and tested in the laboratory using simulants for the individual phases. (3) Installation, calibration, and operation of the instrument on site at the Wilsonville SRC-1 plant in Alabama. The techniques used for the measurement are a combination of high and low energy gamma densitometry. Simulation studies performed in Phase I showed that, with the present knowledge of the process stream, no instrument could distinguish well between unreacted coal and liquid present in the mixture at the point of measurement. Thus solid fraction was taken to be the ash only. The instrument was installed and tested at Wilsonville in normal plant operating conditions and over a series of special test conditions. The applicability of this technique to the severe environmental and process conditions of coal derived synfuels was demonstrated. The gauge is operational with a preliminary calibration. Further work is required to refine the calibration and to gain operating experience over a wider range of plant conditions.

24399 (DOE/PC/60036—14) Supercritical fluid extraction of coal: Technical progress report, 12/1/86-2/28/87. Greenkorn, R.A.; Chao, K.C. (Purdue Univ., Lafayette, IN (USA). School of Chemical Engineering). 1987. Contract FG22-83PC60036. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007383.

The objectives of the research described in this progress report are to study extraction of coal with supercritical mixtures of ammonia and water and to develop a group contribution equation of state to describe the supercritical region. During the past quarter, experiments designed to measure the conversion of an Illinois No. 6 bituminous coal and a Wyodak subbituminous coal as a function of solvent temperature were continued. The solvent employed was either steam or a mixture of steam and ammonia. Along the course of an extraction run, the solvent temperature was increased in a step-wise fashion starting at 200 to 300°C and ending at approximately 400°C. Two to five steps were taken per run. The solvent temperature was maintained at the same level for three hours after every step. These data were shown fitted with least-square lines in Figure 1. The coal conversions for these extractions were compared with the conversions for extractions which differed only in that the solvent temperature was maintained at the final temperature from start to finish. In all cases studied, conversion was increased by heating in a step-wise fashion, as much as 20% in the case of Wyodak extracted with ammonia/steam. The addition of ammonia to the solvent appeared to improve the conversion of both coals because it increased the rate of conversion. If the run times were extended, one would expect a smaller difference between the conversion curves of a particular coal. In the future, the reaction products will be characterized using IR, NMR, FIMS, simulated distillation, and elemental analyses, and the product gases will be analyzed to complete the material balance. 4 refs., 1 fig., 3 tabs.

24400 (DOE/PC/60813—14) Hydrotreatment catalyst activity enhancement: Quarterly report No. 14 for the period November 1, 1986 to January 31, 1987. Seapan, M.; Crynes, B.L. (Oklahoma State Univ., Stillwater (USA). School of Chemical Engineering). Feb 1987. Contract FG22-83PC60813. 19p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006802.

The series of experiments on the hydrogenation of Tetralin and quinoline mixtures was completed. The analysis of coke on the catalyst showed that in most cases titanocene dichloride reduced the coke formation on the catalyst. Additional runs were conducted on the hydrodesulfurization of dibenzothiophene. In hydrotreatment of SRC-II middle distillate, addition of titanocene dichloride showed no effect on desulfurization rate in noncatalytic experiments. In the catalytic hydrotreatment of SRC-II middle distillate, the effect of titanocene dichloride on catalyst coking, pore volume and surface area was insignificant. 10 tabs.

24401 (DOE/PC/70018—34) Coal liquefaction process solvent characterization and evaluation: Technical progress report, July 1, 1986 through September 30, 1986. Robbins, G.A.; Winschel, R.A.; Burke, F.P. (Conoco, Inc., Library, PA (USA). Coal Research Div.). Mar 1987. Contract AC22-84PC70018. 59p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007857.

Conoco Coal Research Division is characterizing samples of direct coal liquefaction process oils based on a variety of analytical techniques to provide a detailed description of the chemical composition of the oils, to more fully understand the interrelationship of process oil composition and process operations, to aid in plant operation, and to lead to process improvements. The approach taken is to obtain analyses of a large number of well-defined process oils taken during periods of known operating conditions and known process performance. Close cooperation is maintained with the process developers and with DOE in order to maximize the benefits of the work. Analytical methods used are based on their ability to provide quantitatively valid measures of process oil composition. Particular use is made of methods which provide chemical/molecular information of proven relevance to process performance. In addition, all samples are treated using conventional methods of analysis and preparation so that unit performance parameters, such as conversions and yields, can be independently determined to assure sample validity and correlation of analytical results among various plant operations. 10 refs., 3 figs., 20 tabs.

24402 (DOE/PC/70030—T7) Novel Fischer-Tropsch slurry catalysts and process concepts for selective transportation fuel production: Quarterly technical progress report for the period 1 April-30 June 1986. Carroll, W.E.; Eliezer, K.F.; Mitchell, J.W.; Withers, H.P. Jr. (Air Products and Chemicals, Inc., Allentown, PA (USA)). Feb 1987. Contract AC22-84PC70030. 239p. NTIS, PC A11. File Number DE87006115.

In the seventh, and final quarter, work continued on the three major tasks: Task 2 - Development of Improved Supported Catalyst Compositions, Task 3 - Slurry Reactor Kinetic Studies, and Task 4 - Fuel Product Characterization. To examine the importance of surface area effects on the activity enhancement of the Co/Zr/silica catalyst, a Co/Zr/silica catalyst having the same surface area as the Co/Zr/alumina catalyst was tested in the fixed bed reactor. Silica provided an inherently more active catalyst than alumina but some of the enhancement that was initially observed was due to the increased surface area. The effect of increasing metal loadings on the performance of the Co/Zr/silica catalyst was examined with tests of 11% and 14.4$ Co catalysts in the fixed bed reactor. The 11% Co catalyst gave the highest syngas conversion (52%) at 220°C of any catalyst tested at this temperature during this contract. Selectivity to liquid fuel product declined with increasing Co loading with an overall flattening of the hydrocarbon distribution. Slurry screening tests were performed on two catalysts. One was a cobalt on silica catalyst without any added promoter atoms such as Zr or Ti. The other screening test was a Zr promoted cobalt on silica catalyst with a high loading of Co. The extended slurry test which was begun in December 1985 was completed in June. During this quarter, a series of experiments was run to try to determine reaction kinetics. The spent catalyst from the extended slurry test of the Co/Zr/SiO$_2$ catalyst was found to contain 43.2% carbon and 2.4% hydrogen. This indicated a significant amount of coke formation. A second sample of liquid organic product was collected from the extended slurry test for testing as a diesel fuel. This sample met all the requirements for the highest quality diesel fuel except for viscosity and cloud point. 6 refs., 57 figs., 98 tabs.

24403 (DOE/PC/70753—T10) The study of some transition metals complexes as process catalysts: Quarterly report for the period December 1, 1986 through February 28, 1987. Wilson, B.L. (Texas Southern Univ., Houston (USA). Dept. of Chemistry). 1987. Contract FG22-84PC70753. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007402.

During this past quarter, zinc complexes with poly(pyrazolyl)borate ligands were prepared, characterized and tested as coal liquefaction catalysts under various conditions. The structures and physical properties of the ligands potassium dihydrobis(pyrazolyl)borate, potassium hydrotris(pyrazolyl)borate and potassium tetrakis(pyrazolyl)borate were consistent with what had been reported in the literature. Spectral studies included infrared and NMR.

24404 (DOE/PC/70780—T6) Trifunctional catalysts for conversion of syngas to alcohols: Tenth quarterly report for period December 1, 1986 to February 28, 1987. Bischoff, K.B.; Manogue, W.H.; Mills, G.A. (Delaware Univ., Newark (USA). Center for Catalytic Science and Technology). 25 Mar 1987. Contract FG22-84PC70780. 32p. NTIS, PC A03. File Number DE87007384.

Changes in adsorption sites on Rh/Al$_2$O$_3$ catalysts brought about by addition of sodium or by molybdena, was quantified by adsorption of hydrogen and of carbon monoxide. Fresh and used catalyst were tested. XRD was done to rule out the presence of crystalline compound formation. Infrared measurements showed that C-O bond is strengthened slightly by molybdena addition. Hence the enhanced activity of Rh/Mo/Al$_2$O$_3$ is caused neither by a greater number of CO sites nor by weakening of CO bond. The role of sodium in removing surface -OH groups, which in turn changes the distribution of different carbonyl species on the surface, was tested. Detailed kinetic data for Rh/Mo/Al$_2$O$_3$ having different amounts of molybdena were collected. Analysis of rate of formation for primary products were carried out. Activation energies for various reactions were calculated and its implication on the reaction scheme is discussed. The analysis of secondary reactions is underway. 6 figs., 4 tabs.

24405 (DOE/PC/70801—T10) Thermodynamic properties for supercritical coal conversion: Quarterly progress report, 1/1/87-3/31/87. Eckert, C.A. (Illinois Univ., Urbana (USA). Dept. of Chemical Engineering). 1987. Contract FG22-84PC70801. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008186.

Supercritical fluids (SCF's) are the medium for an exciting new separation technology which has the potential to provide a way to selectively remove the desirable or undesirable components from coal. Our objective is to investigate the thermodynamic properties of supercritical fluids pertinent to the extraction and/or reaction of coal. Specifically, we are measuring the solubilities of representative coal compounds in a variety of supercritical fluids. During this quarter, we measured the solubility of anthracene, thioxanthone, and xanthone in SC butane at 157, 162, and 182°C. In order to expand the current solubility database of low temperature solvent studies, measurements were made with carbon dioxide at temperatures of 35, 50, and 70°C and at pressures in the range of 100 to 420 bars. The solutes that were investigated include dibenzofuran, dibenzothiophene, and thianthrene. Results indicate higher solubilities can be obtained using SC butane. This solvent is likely to be better suited to coal processing applications.

24406 (DOE/PC/70809—T13) Microbial screening test for lignite degradation: Quarterly progress report No. 9 for the period January-March 1987. Yen, Teh Fu. (University of Southern California, Los Angeles (USA)). Mar 1987. Contract FG22-84PC70809. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007684.

Anaerobic fermentation of water soluble fraction of modified lignite was attempted. Solubilized lignite formed bioprecipitate after biodegradation. Fermentation of water solubilized lignite in enrichment media produced gases and organic acids. FT-IR spectra of solubilized lignite after biodegradation showed that the concentration of organic oxygen have decreased and that the concentration of -CH$_3$ terminal group have increased. Solubilized lignite may serve as sole carbon source by using selective media. Bacteria was suspected of being able to utilize fulvic-like materials from solubilized lignite. Isolation of anaerobic bacteria was achieved by surface culture, and it indicated morphological differences among isolated colonies. Alginate gel entrapment, an immobilization method, was applied to T. versicolor fungal cells. Active fungal growth was observed from the immobilized spheres on sodium-alginate gel. It seems that the immobilized biocatalysts may be used to enhance the production of bioextract from lignite in a reactor system. Hydroxylation of lignite was accomplished through Fenton reaction at pH 7.5. FT-IR analysis showed that lignite treated with Fenton's reagent exhibits weaker aromatic bending and ether linkage than untreated lignite. 13 refs., 8 figs.

24407 (DOE/PC/70810—3) Solvent-mediated hydrogenolysis in coal liquefaction: Quarterly report No. 3 for the period April 16, 1985 to September 15, 1985. McMillen, D.F.; Malhotra, R.; Nigenda, S.E. (SRI International, Menlo Park, CA (USA)). Mar 1987. Contract FG22-84PC70810. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007115.

The objective of the present study is to explore the relevance of solvent-mediated hydrogenolyses to coal liquefaction. To this end we have investigated the cleavage rates of suitable model compounds in a variety of solvent systems with and without added coals, and assessed the relative importance of hydrogenolysis via free H-atoms and via radical hydrogen-transfer (RHT). We have been able to differentiate between hydrogenolysis via free H-atoms from that via RHT by examining the selectivity of cleavage of 1,2'-dinaphthylmethane. To further aid our understanding of the competition in cleavage of strong bonds by various modes of H-transfer, we have also conducted some mechanistic modeling studies. Finally, we are also trying to understand the impact of mass transport limitations on hydrogen shuttling during coal liquefaction. Our approach is to test the ability of solvents to shuttle hydrogen from one part of a heterogeneous system to another by bonding model structures to silica so that these structures, whose cleavage can be precisely monitored, are unable to migrate to the coal structure where the hydrogens become available. 5 refs., 1 fig.

24408 (DOE/PC/80015—6) Fischer-Tropsch slurry phase process variations: Quarterly report for period January 1, 1987 to March 31, 1987. Satterfield, C.N.; Matsumoto, D.K.; Donnelly, T. (Massachusetts Inst. of Tech., Cambridge (USA)). 1987. Contract AC22-85PC80015. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008302.

The results of a detailed series of studies are reported herewith on the effects of adding ethanol during Fischer-Tropsch synthesis on a reduced fused magnetite catalyst at 248°C and 9.2 atm. Ethanol decreased the hydrogenation capabilities of the catalyst as reflected in lower CH_4 formation and higher olefin-paraffin ratio of the products. The value of α (C_3-C_7) based on hydrocarbons was unaffected, but increased quantities of acetaldehyde, C_3 oxygenates and ethyl acetate were found. We found no evidence for significant ethanol incorporation into growing chains. This is consistent with previous studies by Kummer et al. (1951) and Kokes et al. (1957) with radioactively-labelled ethanol. In their work, incorporation into growing chains decreased markedly with increasing pressure and less occurred over a doubly promoted iron catalyst (MgO, K_2O) than over a singly promoted catalyst (ThO_2). The catalyst here was triply promoted (Al_2O_3, K_2O, CaO). 1 fig., 2 tabs.

24409 (DOE/PC/80502—T4) Interactive chemistry of coal-petroleum processing: Progress report, September 16, 1986-December 15, 1986. Curtis, C.W.; Guin, J.A.; Tarrer, A.R. (Auburn Univ., AL (USA). Coal Conversion Lab.). 1986. Contract FG22-85PC80502. 50p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006667.

The objective is to investigate the thermal and catalytic chemistry of coal-petroleum processing using model compounds and actual petroleum-coal materials. The work performed has focused upon: (1) an experimental investigation of the interactive chemistry of coal-petroleum hydrocarbon systems and coal-petroleum hydrocarbon and heteroatom systems: (2) experimental work using an oil-soluble catalyst, Mo naphthenate as a model organometallic for the investigation of the effect of organometallics and petroporphyrins on the interactive chemistry of coal petroleum processing; and (3) a literature review investigating the catalytic effect of vanadium in upgrading heavy ends. 22 refs., 28 tabs.

24410 (DOE/PC/90533—2) Deactivation by carbon of iron catalysts for indirect liquefaction: Quarterly technical progress report for period December 16, 1986 to March 15, 1987. Bartholomew, C.H. (Brigham Young Univ., Provo, UT (USA)). 20 Apr 1987. Contract FG22-86PC90533. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008433.

During the second quarter significant progress was made in the design and construction of a computer-automated reactor system to be used in the kinetic and deactivation studies. A portion of the computer software for control of reactor temperature, pressure and flow was written, while about three-fourths of the reactor hardware was installed and tested. A study of literature dealing with deactivation of catalysts by carbon was completed; work was begun on a Ph.D. prospectus, detailing plans for the kinetic and deactivation studies. The PI and several students attended the Second Annual Meeting of the Western States Catalysis Club, received two visitors and published one paper. 46 refs.

24411 (DOE/PC/90909—T2) Low severity coal liquefaction using homogeneous basic nitrogen catalysts: Technical progress report, November 1986-January 1987. Miller, R.L.; Baldwin, R.M. (Colorado School of Mines, Golden (USA). Dept. of Chemical Engineering and Petroleum Refining). 1987. Contract FG22-86PC90909. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006408.

During the second quarter of this project, efforts were directed towards development of a database for low severity coal conversion and distillate yields in the presence of selected model nitrogen compounds. Initial results suggest that the structure of the nitrogen compound used strongly affects liquefaction performance. Dipropylamine was identified as a particularly attractive candidate for use in enhancing coal dissolution. Attempts to correlate the effect of nitrogen compound addition with simple parameters such as pK/sub b/ have not been successful. Additional experimental work directed towards developing methods to reduce or eliminate nitrogen adduction at low severity liquefaction conditions is underway. Results from this work will be reported next quarter. 4 refs., 2 figs., 3 tabs.

24412 (EPRI-AP—5101) Coal-oil coprocessing: Phase 1, Interim report. (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 226p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920341.

This report summarizes the results of Phase 1 of the Coal/Oil Co-Processing Program. The sponsors of the Phase 1 Program included the Electric Power Research Institute (EPRI), Ontario-Ohio Synthetic Fuels Corporation, Ltd. (OOSFC), Alberta Research Council (ARC) and Dynalectron Corporation. OOSFC received financial assistance from the Ohio Coal Development Office. While the overall objective of this program is to further develop and demonstrate HRI's Ebullated-Bed Coal/Oil Co-Processing Technology, the specific objectives of coal/oil co-processing are to: produce incremental liquid fuels from coal and upgrade poor quality petroleum-derived residual fuels. Four coal and four oil feedstocks were selected for the Phase 1 Program based on their near-term commercial interest. The quality of these feedstocks were characterized and batch microautoclave reactivity screening tests were performed. Further batch autoclave reactivity screening experiments were performed on selected feedstocks and feedstock combinations. Two continuous bench-scale operations were completed, in single- and two-stage configurations, using a single feedstock combination (Ohio No. 5/6 coal and Cold Lake residuum). Process performance obtained in the continuous bench unit operations was excellent, with over 90 W % M.A.F. 975°F^{+} conversion, 90% hydrodesulfurization, 80% hydrodenitrogenation and 99% demetallization. Based on the results of the continuous bench-scale operations liquid product characterizations were performed, as well as economic screening studies that identified preferred operating conditions. Finally, commercial planning studies focused on specific locations in the Great Lakes region where coal/oil co-processing may be commercially applied. Further research and development of the coal/oil co-processing technology will be done during Phase 2 of this program. 7 refs., 62 figs., 73 tabs.

24413 **(LBL—22682) Fundamental studies of catalytic gasification: Quarterly report, October 1, 1986-December 31, 1986.** Heinemann, H. (Lawrence Berkeley Lab., CA (USA)). Dec 1986. Contract AC03-76SF00098. 24p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007891.

This program studies the basic chemistry of the reaction of carbonaceous materials with water in the presence of catalysts to produce hydrogen and/or synthesis gas. Relatively low temperatures are being used. The catalysts under investigation are compounds of potassium and a transition metal oxide. Major objectives are the extension of the work from chars to coke; the effect of H_2, CO and CO_2 partial pressure on the gaseous product distribution; and the inhibition of catalyst poisoning by ash components. Some of the highlights are: (1) Activation energies for K/Ni catalyzed steam gasification of graphite and of chars are identical, indicating the same mechanism prevails though rates are much higher for chars. This permits extrapolation of findings in high vacuum equipment from graphite to chars. (2) The CO/CO_2 ratio of gases produced along with hydrogen varies with different chars. The ratio is 0.8 for Illinois No. 6 char and 0.08 for North Dakota char. Methane production is several orders of magnitude smaller and ceases after about 2 hours. (3) Comparison of K/Ni catalyst for steam gasification of Illinois No. 6 char with K or Ni alone indicates: (a) K alone produces much higher CO/CO_2 ratios than K/Ni. (b) Ni alone is almost inactive for the steam gasification of Illinois No. 6 except for the short first period of operation. (4) Montana char treated with aqua regia to remove ash components prior to impregnation with K/Ni has 75% of the activity of untreated char but exhibits little deactivation with time so that it gasifies better than untreated char after a few hours. (5) Controlled atmosphere electron microscopy studies have been extended to wet hydrogen and wet oxygen treatments of K/Ni impregnated graphite 3 refs., 8 figs., 2 tabs.

24414 **(NP—7751713) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.1.3. Pt. 1 and 2. Pt. 1: Autothermic and nuclear gasification systems. Pt. 2: Gas production cost.** (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). 1986. 109p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE87751713.

In the framework of investigations regarding possible uses of the alternative energy sources gas, electricity, and district heat, a two-part contribution is made regarding autothermic and nuclear coal gasification systems as well as regarding the cost of gas production. The first part deals with the bases of gas production from coal (reactions, basic principles of the process, gas treatment). This is followed by a comparison of the state of the art (Lurgi pressure gasification, Shell-Koppers pressure gasification, nuclear coal gasification) and its possibilities of production. A further topic is waste heat utilization from coal gasification facilities (autothermic and nuclear gasification, interconnected plant, coal-gasification/combined-cycle power plant). The second part looks into the economic efficiency of gas produced by coal gasification. The calculation of gas production cost is explained (cost of production of synthetic natural gas in 1982 and 1988 as well as in the year 2008). The calculation results are laid down in numerous tables. (HWJ).

24415 **(NP—7770078) Two-dimensional, two-phase hybrid simulation model of allothermal vapour gasification of coal in fluidized-bed systems.** Udaquiola de Garces, S.M. (Technische Hochschule Aachen (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet). 24 May 1984. 171p. (In German). NTIS (US Sales Only), PC A08. File Number DE87770078.

The author investigates a fluidized-bed gasification receiving process heat from a gas-coooled HTR. The investigation focuses on the mathematical modelling of the gasifier. The establishment of suitable parameters and the solution of systems of equations are described. Hybrid simulation as well as the necessary hardware and software are presented. The results, potential applications, and shortcomings of the model are presented. (HAG).

24416 **(NP—7770079) Fluidized-bed gasification - effects of flow rates and post-gasification.** Dicke, U. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 4 Jul 1985. 132p. (In German). NTIS (US Sales Only), PC A07. File Number DE87770079.

Of the present gasification processes, fluidized-bed gasification is the most favourable both from the energetic and the environmental point of view. The author describes the influence of gas supply rates on the gasifier performance and on the possible formation of agglomerates in reactors with post-gasification zones. The effects of additives are investigated, and various fluidized-bed gasification processes for lean gas and syngas production are compared. The semi-industrial HTW facility is described and its performance reviewed. (HAG).

24417 **(NP—7770081) Desulphurisation of hot reduction gases in an entrained-flow reactor.** Willerding, H. (Technische Univ. Berlin (Germany, F.R.). Fachbereich Verfahrenstechnik). 4 Dec 1985. 145p. (In German). NTIS (US Sales Only), PC A07. File Number DE87770081.

The author investigates the desulphurisation of the gases from coal gasification and their utilisation as reduction or combustion gases. A semi-industrial experimental plant is described. The following parameters, that may influence the desulphurisation efficiency, are investigated: Temperature, time of residue, H/sub 2/S and desulphurisation agent concentrations, particle size distributions of the desulphurisation agent, gas composition. The experimental results are compared with thermodynamic equilibrium calculations and used for mathematical modelling.

24418 **(PB—87-147450/XAB) Control technology research and environmental methodologies for the mitigation of underground-coal-gasification impacts: research plan for task 2 - control technology evaluation for UCG-affected subsurface waters. Topical report, July 1985-March 1986.** Nolan, B.T.; Kocornik, D.J.; Boelter, A.M.; Bergman, H.L. (Western Research Inst., Laramie, WY (USA)). Jul 1986. 91p. NTIS, PC A05/MF A01.

See also Task 2 Final Report dated Sep 86, PB—87-147468.

A UCG-affected subsurface water was synthesized with altered groundwater and process condensate from the Hanna, Wyoming UCG site. Results of preliminary analyses indicate that concentrations of organics in the UCG-affected subsurface water closely resemble worst-case contamination expected after UCG operations. The subsurface water contained significant amounts of phenols, ammonia, total dissolved solids, sulfate, and selected metals, compared with preburn concentrations in Hanna subsurface water. A literature review was performed to identify cost-effective treatments for removal of the UCG-induced contaminants. Coagulation-precipitation, hot-gas stripping, activated-carbon adsorption, and reverse osmosis were recommended for a feasibility study to be performed with the UCG-affected subsurface water, based on the results of the literature review. The objective of all treatments was the reduction of contaminants to preburn levels. Analytical quality-control procedures and a methodology for the bench-scale evaluation of the recommended treatments were presented.

24419 **(PB—87-147468/XAB) Control technology research and environmental methodologies for the mitigation of underground-coal-gasification impacts: Task 2 final report - control-technology valuation for UGG-affected subsurface waters. Topical report, August 1985-September 1986.** Nolan, B.T.; Kocornik, D.J.; Boelter, A.M.; Bergman, H.L. (Western Research Inst., Laramie, WY (USA)). Sep 1986. 172p. NTIS, PC A08/MF A01.

See also report dated Jul 86, PB—87-147450.

A UCG-affected subsurface water sample was synthesized with altered groundwater and process condensate from the Hanna, Wyoming, UCG site. The concentration of dissolved organic carbon in the water sample closely resembles worst-case contamination of groundwater by soluble organics resulting from UCG. Hot-gas stripping, activated carbon adsorption, coagulation-precipitation, and reverse osmosis were evaluated in a bench-scale treatability study for ability to remove organic and inorganic contaminants from the UCG-affected water. The objective of all treatments was to reduce contaminant concentrations to preburn levels. Ammonia, phenols, calcium hardness, total dissolved solids, sulfate, and selected metals were effectively removed by the process train. The toxicity of the UCG-affected water was reduced substantially by the combination of treatments. Hot-gas stripped, carbon-adsorbed effluent was not lethal to aquatic test organisms at the 100% wastewater concentration.

24420 (UCID—20951) Preliminary test plan for an underground coal gasification experiment in the Triunfo coal of Brazil. Hill, R.W.; Thorsness, C.B. (Lawrence Livermore National Lab., CA (USA)). Dec 1986. Contract W-7405-ENG-48. 37p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008342.

The test plan described here is the first part of a larger test series intended to culminate in a pre-commercialization pilot plant facility. The results from this test will be used to provide realistic cost data to evaluate the rest of the program. If the decision is made to go ahead with the program, then a detailed design will be made based on the results obtained and a long term (up to two years), multi-module test series will be started. Although a conceptual plan for the larger test series will be included as part of this plan, there are certain basic parameters of the system that need to be measured by the first test before the detailed design is possible. At the present time the US experience is all related to thicker coal seams where the burn cavity width has been of the order of twice the seam thickness. If this holds true for the thinner Triunfo coal, then the test duration will be about 40 days and the coal consumption and gas quality should be as predicted by our model and as given later in this report. However, the Russian literature indicates that the relationship between cavity width and seam thickness is not the same for thin seams and that perhaps the width may be as much as 4 to 5 times the seam thickness but with poorer gas quality. The test described here in this report is designed to provide the needed data to establish the cavity width relationship for the Triunfo coal resource. Once the data and the construction cost data are available, the design of a larger pilot plant size facility can proceed with some confidence. 12 figs., 1 tab.

24421 Process for electrochemically gasifying coal using electromagnetism. Botts, T.E.; Powell, J.R. (to Dept. of Energy, Washington, DC). US Patent 4,643,809. 17 Feb 1987. Filed date 25 Oct 1985. vp.

A process is described for electrochemically gasifying coal, comprising the steps of: (a) establishing a flowing stream including a slurry of coal particulate and a liquid, electrode members distributed in the slurry, and an electrolyte in electrically conducting relationship with the members and the slurry, (b) establishing a magnetic field of predetermined strength transversely through a portion of the stream. The field is effective to electrically polarize the electrode members as they flow through the field, thereby causing the members to operate with the electrolyte to electrochemically gasify the coal particulate and generate H/sub 2/ and CO/sub 2/ gases at opposite ends, respectively, of the members, (c) providing gas collecting means operatively positioned to collect the gases as they rise from the slurry, and operating the gas collecting means to collect the gases.

24422 Effect of slurry heating rate on short-contact-time coal liquefaction. Wham, R.M. (Oak Ridge National Lab., TN). *Fuel;* **66**: No. 2, 283-284(Feb 1987).

The effects of changes in heating rate of a coal/solvent slurry on conversions to pyridine-soluble material have been examined. Dramatic increases in conversions were observed when the coal/solvent mixture was maintained at a temperature of 589 K for 10 min before heating to reaction conditions of 700 K for 5 min. In particular, conversion increased from 32.0 to 76.7 wt% and the ratio of oils to preasphaltenes increased by a factor of four. The temperature range for the greatest effect is observed to be 550-595 K while 450 K shows no change in conversion. The mechanism is thought to be chemisorption of the solvent or solvent occlusion which would increase the concentration of hydrogen donor in the coal matrix thus affecting the reaction environment. Additional studies to further define the details of the programmed heating rate as well as explore the mechanisms are needed. 12 references, 3 tables.

24423 Two-stage coal liquefaction without gas-phase hydrogen. Stephens, H.P. (to Dept. of Energy). US Patent Application 6-871,192. 5 Jun 1986. 32p. Contract AC04-76DP00789. DE87007186 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007186.

A process is provided for the production of a hydrogen-donor solvent useful in the liquefaction of coal, wherein the water-gas shift reaction is used to produce hydrogen while simultaneously hydrogenating a donor solvent. A process for the liquefaction of coal using said solvent is also provided. The process enables avoiding the use of a separate water-gas shift reactor as well as high pressure equipment for liquefaction. 3 tabs.

24424 Process and apparatus for coal hydrogenation. Ruether, J.A. (to Dept. of Energy). US Patent Application 6-867,124. 27 May 1986. 27p. DE87007256 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007256.

In a coal liquefaction process an aqueous slurry of coal is prepared containing a dissolved liquefaction catalyst. A small quantity of oil is added to the slurry and then coal-oil agglomerates are prepared by agitation of the slurry at atmospheric pressure. The resulting mixture of agglomerates, excess water, dissolved catalyst, and unagglomerated solids is pumped to reaction pressure and then passed through a drainage device where all but a small amount of surface water is removed from the agglomerates. Sufficient catalyst for the reaction is contained in surface water remaining on the agglomerates. The agglomerates fall into the liquefaction reaction countercurrently to a stream of hot gas which is utilized to dry and preheat the agglomerates as well as deposit catalyst on the agglomerates before they enter the reactor where they are converted to primarily liquid products under hydrogen pressure. 6 tabs.

24425 Low temperature pyrolysis of coal or oil shale in the presence of calcium compounds. Khan, M.R. (to Dept. of Energy). US Patent Application 6-853,117. 17 Apr 1986. 21p. DE87007233 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007233.

A coal pyrolysis technique or process is described in which particulate coal is pyrolyzed in the presence of about 5 to 21 wt % of a calcium compound selected from calcium oxide, calcined (hydrate) dolomite, or calcined calcium hydrate to produce a high quality hydrocarbon liquid and a combustible product gas which are characterized by low sulfur content. The pyrolysis is achieved by heating the coal-calcium compound mixture at a relatively slow rate at a temperature of about 450 to 700°C over a duration of about 10 to 60 minutes in a fixed or moving bed reactor. The gas exhibits an increased yield in hydrogen and C_1 to C_6 hydrocarbons and a reduction in H_2S over gas obtainable by pyrolyzing coal without the calcium compound. The liquid product obtained is of a sufficient quality to permit its use directly as a fuel and has a reduced sulfur and oxygen content which inhibits polymerization during storage.

24426 Method for the desulfurization of hot product gases from a coal gasifier. Grindley, T. (to Dept. of Energy). US Patent Application 6-850,301. 10 Apr 1986. 15p. DE87007230 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007230.

The gasification of sulfur-bearing coal produces a synthesis gas which contains a considerable concentration of sulfur compounds, especially hydrogen sulfide that renders the synthesis gas environmentally unacceptable unless the concentration of the sulfur compounds is significantly reduced. To provide for such a reduction in the sulfur compounds a calcium compound is added to the gasifier with the coal to provide some sulfur absorption. The synthesis gas from the gasifier contains sulfur compounds and is passed through an external bed of a regenerable solid absorbent, preferably zinc ferrite, for essentially completed desulfurizing the hot synthesis gas. This absorbent is, in turn, periodically or continuously regenerated by passing a mixture of steam and air or oxygen through the bed for converting absorbed hydrogen sulfide to sulfur dioxide. The resulting tail gas containing sulfur dioxide and steam is injected into the gasifier where the sulfur dioxide is converted by the calcium compound into a stable form of sulfur such as calcium sulfate. 2 figs.

24427 **Chemical cleaning of Illinois No. 6 coal using a microwave/caustic treatment.** Richardson, C.K.; Bluhm, D.D.; Markuszewski, R.; Durham, K.S.; Green, T.M.; Fanslow, G.E. (Fossil Energy Program, Ames Lab., Iowa State Univ., Ames). pp 130-144 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—). Contract W-7405-ENG-82.

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

A chemical coal cleaning process has been tested in which Illinois No. 6 coal (precleaned by floating at 1.6 sp. gr.) has been mixed with water and caustic (NaOH, KOH, or NaOH-KOH mixtures) to form a slurry, irradiated with microwave energy, and washed with water, acid, and again with water. An experimental microwave applicator system, consisting of a tuned resonant cavity (4" diameter by 24" long) and a microwave generator (up to 6 kW at 2450 MHz), was used to process 50-gram batch samples of coal. Numerous experiments were conducted in this apparatus under an inert atmosphere of argon gas to determine the operating conditions which result in the lowest levels of residual sulfur and ash in the product coal and at the same time to minimize the consumption of reagents and raw materials. The data collected from these experiments were used to determine the best conditions for maximum sulfur and ash removal from the precleaned Illinois No. 6 coal. Under these best conditions, nearly all of the pyritic sulfur, most of the organic sulfur, and most of the ash could be removed, leaving a coal product containing less than 2% ash (initially 15.4% ash) and less than 0.7% sulfur (initially 3.43%).

24428 **Steam and oxidative desulfurization of coal.** Soo, S.L.; Li, Q.; Lake, M.A. (Dept. of Mechanical and Industrial Engineering, Univ. of Illinois at Urbana-Champaign, 1206 West Green Street, Urbana, IL). pp 65-70 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

Study has shown the usefulness of oxidative desulfurization of Illinois coals with steam as a carrier of oxygen. Subsequent steam treatment removed the bulk of the sulfur in coal. The condensate from the process as applied to Herrin No. 6 coal contained a tar of high fluidity and an off-gas consisting of hydrogen, carbon monoxide, hydrocarbons, and sulfur compounds in these fluid phases (33 percent in the off-gas and 2.6 percent in the liquid tar). These forms of sulfur contents facilitate removal by standard refinery processes. The gas and liquid tar thus cleaned of sulfur, when recombined with the desulfurized coal, can be burned at almost the original proportion of volatile matter. In this way, the coal did not become a char after the removal of up to 90 percent of its sulfur. By itself, the solid after desulfurization still retained one-third of the original volatile matter. The phenolic liquid yield (1.2 barrel per ton of coal) of high fluidity then becomes a by-product for use as refinery feedstock.

24429 **Reactivities of in-situ and non-in-situ coal chars during gasification in steam at 1000 to 1400°C.** Peng, F.F.; Lee, I.C.; Yang, R.Y.K. (Dept. of Chemical Engineering, West Virginia Univ., Morgantown, WV 26506-6101). pp 730-746 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

It is well known that pyrolysis condition strongly affects the reactivity of char and hence the overall performance of a coal gasifier. In commercial operation, coal particles in a gasifier undergo pyrolysis and gasification continuously under more or less the same condition; and yet most of the char gasification data reported in the literature were obtained under gasification conditions that were quite different from the pyrolysis conditions under which the chars were prepared. An important feature of this work is to obtain more realistic kinetic data by continuously monitoring weight-losses of char starting from coals rather than from separately prepared chars, although for purpose of comparison the latter were also prepared and their reactivities measured. The objective of this investigation is to gain a better understanding of char-steam reaction under conditions similar to that existed in a number of commercial coal gasification processes.

24430 **Fundamental studies on mineral matter behavior in ash-agglomerating coal gasifiers.** Carty, R.H.; Mason, D.M.; Babu, S.P. (Institute of Gas Technology, 3424 So. State St., Chicago, IL 60616). pp 717-729 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

The Institute of Gas Technology (IGT) is conducting a research program on ash chemistry to predict the behavior of the mineral matter in a fluidized-bed gasifier and its downstream units based on a minimum analysis of the characteristics of the mineral matter present in the coal feed and on the operating conditions. The bench-scale fundamental research investigation on the behavior of mineral matter, contained in chars from Pittsburgh Seam Coal from the Consolidation Coal Company's Ireland Mine in Marshall County, West Virginia, and from the No. 11 seam of Kentucky coal, were conducted in a 2-inch ID gasifier with a perforated plate gas distributor at atmospheric pressure, at 1255 and 1366 K, with char carbon conversions ranging from 24% to 94%. Some of the tests were conducted with low oxygen, 0.31 to 0.32 mole percent in the feed gas and others with 5.0 to 5.7 mole percent oxygen to investigate the effect of temperature due to the reaction of oxygen with the char. Another group of six eastern and two western coals are presently being tested with a center jet added to the perforated plate gas distributor.

24431 **Novel concepts for the production of high-density transportation fuels.** Fraser, M.D. (Science Applications International Corp., 8200 Greensboro Drive, Suite 600, McLean, VA 22102). pp 608-627 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

The most important objective of this study was to identify novel and innovative concepts for producing high-density fuels from coal via liquefaction. Specifications and characteristics of both conventional and high-density transportation fuels were analyzed. Current knowledge regarding the production of high-density fuels is also summarized in this report. In this study, state-of-the-art concepts of coal liquefaction were examined to identify novel broad processing concepts which could lead to the production of high-density transportation fuels. Concepts found could be grouped into three general process categories: direct liquefaction with a donor solvent, mild pyrolysis, and extraction/reaction with a supercritical solvent. The potential application of these three process concepts to the production of high-density fuels is described. Technical, economic, and strategic issues concerning the development of high-density fuels are discussed.

24432 **Mixing studies in rapid pyrolysis with steam stabilization.** Albal, R.S.; Westra, L.F.; Gannon, R.E.; Stickler, D.B.; Woodroffe, J.A.; Neoh, K.G. (Avco Research Lab., Everett, MA 02149). pp 628-641 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

This paper describes the experimental results of a mixing study for high temperature coal pyrolysis in a two-stage entrained flow reactor. These experiments were carried out in Avco's high throughput entrained flow reactor facility. To optimize the pyrolysis yield, several coal and steam injector geometries were used to achieve uniform dispersion of coal particles in the hot background gases. The differences in the geometries included the relocation of steam and coal injectors, the addition of conical coal deflector, and swirl devices. To visually observe the mixing patterns, cold flow analog was developed by matching several dimensionless hydrodynamic groups with the hot recting gasifier system. Maintaining essential geometric similarity with that of the gasifier, a glass apparatus was designed and constructed. Experiments were carried out using air to simulate the main flow and spherical glass beads carried by nitrogen to simulate the coal feed. Photographic techniques were used to study the mixing and spatial distribution of solids. Several solid injector geometries were used for these cold-flow experiments. The results from the cold flow tests and coal conversions from hot flow runs indicate that the improvement in mixing results in higher conversion yields to the point where the pyrolysis yield is no longer limited by gross, time-averaged mixing behavior but rather by chemical kinetics.

24433 **Particle separation in a fluidized bed containing a high-velocity jet.** Zhang, J.Y.; Zhang, B.J.; Chitester, D.C. (Institute of Coal Chemistry, Academia Sinica, P.O. Box 165, Taiyuan, Shanxi). pp 491-504 of Proceedings of the 11th annual powder and bulk solids conference and exhibition. Des Plaines, IL; Cahners Exposition Group (1986). (CONF-8605168—).

From 11. annual powder and bulk solids conference/exhibition: powder and bulk solids handling and processing; Rosemont, IL, USA (13 May 1986).

The high-velocity jet region of a jetted fluidized bed plays an important role in momentum, mass, and heat transfer in the bed. A two-dimensional, fluidized-bed cold model equipped with a high-velocity jet was constructed to study the role of this high-velocity region. The effect of various operating parameters on particle separation was studied. These parameters include jet geometry, jet velocity, and particle size and density. The separation rate, separation efficiency, and size distribution of separated particles were measured at each jet velocity. From these experiments, some important information on particle separation was obtained. An optimal, jet-zone, geometric configuration was identified for efficient particle separation. A graphical representation of the particle-separation process for heterogeneous solids was developed. This graph divides the particle-separation process into four different types of operation, ranging from maximum separation to zero separation. Empirical equations were developed to calculate initial-separation velocity and critical-separation velocity. Also, effective separation efficiency was found to be directly related to carbon conversion and, consequently, gasification efficiency.

24434 **Catalytic hydroprocessing of synthetic fuels.** Stiegel, G.J.; Krishnamurthy, S.; Shah, Y.T. (Dept. of Energy, Pittsburgh, PA). *Reviews in Chemical Engineering;* 1: No. 4, 357-401(1983).

This paper presents a review of the current state-of-the-art in hydroprocessing of coal liquids, tar sands bitumen, and shale oil. The technology relating to desulfurization, denitrogenation, deoxygenation, demetalation, and hydrogenation is discussed. Catalyst development, together with the mechanisms of deactivation for each feedstock is also discussed. A brief description of the composition of each feedstock is presented to provide the reader with some insight into the nature of the material being processed and a basis from which a comparison between feedstocks can be made. Finally, a summary is presented that highlights important findings and provides recommendations for future research. 103 references.

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REFER ALSO TO CITATION(S) 24391, 24401, 24406, 24412, 24459, 24460, 24473, 24486, 24491, 24493, 24496, 26015

24435 **(CONF-860548—4) Evaluation of CWM dispersants correlating zeta potential, pH, and rheology.** McLaughlin, M.A.; Funk, J.E.; Dinger, D.R. (New York State Coll. of Ceramics, Alfred (USA)). 1986. Contract FG22-84PC70804. 14p. NTIS, PC A02. File Number DE87006444.

From 8. international symposium on coal slurry fuels preparation and utilization; Orlando, FL, USA (27 May 1986).

This is a progress report on research to correlate the measure of Zeta Potential at different concentrations of dispersants and pH with the rheological properties of crowded slurries of coal and ceramic systems. The ceramic powders provide better understood surfaces than coal for evaluation of dispersant effectiveness, and may elucidate the contribution of the ash mineral matter to whole coal CWM's rheology. 11 refs., 18 figs.

24436 **(CONF-870493—1) Pore structure analysis of American coals.** Gallegos, D.P.; Smith, D.M.; Stermer, D.L. (New Mexico Univ., Albuquerque (USA). Powders and Granular Materials Lab.). 1987. Contract FG22-85PC80519. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008022.

From IUPAC symposium on pore structure characterization; Bad Soden, F.R. Germany (26 Apr 1987).

The pore structure of 19 American coals, representing a wide range of rank and geographic origin, has been studied via gas adsorption, mercury porosimetry, helium displacement and NMR spin-lattice relaxation measurements. Nitrogen adsorption at 77 K was used to determine surface area in the pore range of r/sub p/ > ≃ 1nm and carbon dioxide adsorption at 273 K was used to obtain the total surface area. Porosimetry results were complicated by inter-particle void filling, surface roughness/porosity and sample compression. By employing a range of particle sizes, information concerning the relative magnitude of these mechanisms was ascertained as a function of pressure. Spin-lattice relaxation measurements of water contained in saturated coal were used to find pore size distributions over a broad range of T_1, the spin-lattice relaxation time. Good qualitative agreement was obtained between these measurements and gas adsorption/condensation results. 13 refs., 3 figs., 1 tab.

24437 **(DOE/ER/10641—5) Heats of formation, structure, and heteroatom (^{17}O, ^{33}S) NMR studies of organosulfur molecules, radicals, and ions: [Progress report].** Baer, T.; Evans, S. (North Carolina Univ., Chapel Hill (USA). Dept. of Chemistry). [1986]. Contract AS05-80ER10641. 18p. NTIS MF A01; 2; GPO Dep. File Number DE87006361.

Such organosulfur compounds as sulfoxides, thiolsufonates, thiolsulfinates and sulfones will be prepared and investigated by photoionization and photoelectron photoion coincidence (PEPICO) in order to determine the gas phase structures and ground state energies of these molecules and the fragments and ions derived from them. The experimental results will be supplemented by ab initio molecular orbital calculations. A new threshold electron energy analyzer will also be constructed and tested. The application of ^{17}O and ^{33}S NMR spectroscopy to problems in organosulfur chemistry is described with major emphasis on the evaluation and identification of organosulfur constituents of coal and petroleum based materials. An important focus of the research is to determine in a semi-quantitative manner the effects of substituents on ^{17}O and ^{33}S NMR shifts. Continued development of lanthanide shift reagents in ^{17}O NMR spectroscopy as an analytical tool for determination of "oxidized" organosulfur components in "solution" coal samples is also proposed. During this granting period, we will integrate our solution ^{13}C NMR results with those obtained in the solid-state using cross polarization (CP)-magic angle spinning (MAS) techniques. We will also make attempts to observe organosulfur components directly in the solid state using CP-MAS techniques.

24438 (DOE/PC/70771—T5, pp 2.2-2.15) **Single-pulse shock tube studies of global rates and mechanisms of NO and HCN reactions on flame-borne particulates: Quarterly report No. 4.** Lester, T.W.; Cheng, M.T.; Kirsch, M. (Louisiana State Univ., Baton Rouge). 1987. NTIS, PC A06/MF A01. File Number DE87006703.

In Kinetics of nitrogen and sulfur reactions in combustion systems: Quarterly report No. 7.

Nitric oxide (NO) reactions on carbon black particulates were studied in a two inch single-pulse shock tube in the temperature range from 1400 to 2100K, with particulate mass concentrations up to 50 g/m^3, pressure and reaction time approximately 2 atm and 1 ms, respectively. A light transmission system set up to measure the suspended particle concentration in the test section provides not only an on-line monitoring of an aerosol cloud, but also information regarding the dispersion efficiency of the powder aspirator. The light transmission data were analyzed and compared with the total mass loading measured with a balance. The volatile contents of the carbon blacks were investigated. The gaseous species produced during the pyrolysis of the carbon blacks in Ar consist of hydrocarbons, CO and CO_2 with a total yield of approximately 9% by weight at 2040K. In order to remove the volatile matter, a standard method, which is usually applied to rank the volatile content of coal, has been used to devolatilize the carbon blacks. During the devolatilization process, the powders were heated in a furnace with Ar flow at 1200K for 7 minutes. The results of the pyrolysis of these treated powders showed a reduction in C_2H_2 and CO contents. Experiments have been conducted with these devolatilized powders on the NO/carbon black reaction in Ar gas and with NO mixtures. At 1500K, no NO reduction was detected, although some amount of volatile matter, about 1% by weight, had been emitted from the powder. The rate constants for the reaction of NO on carbon blacks are in the range between 5.5×10^{-6} to 7.2×10^{-5} moles . sec^{-1} cm^{-2} atm^{-1}. 4 refs., 4 figs., 3 tabs.

24439 (DOE/PC/70771—T5, pp 4.1-4.11) **Analysis of combustion gas samples for nitrous oxide.** Grogan, T.C.; Kramlich, J.C. 1987. NTIS, PC A06/MF A01. File Number DE87006703.

In Kinetics of nitrogen and sulfur reactions in combustion systems: Quarterly report No. 7.

Accurate measurement of nitrous oxide (N_2O) in combustion effluent has always been a challenging problem. Although molecular beam mass spectroscopy and gas chromatography/mass spectroscopy have been used in laboratory studies, these are rarely applied to practical combustors. The techniques of choice usually fall into two broad categories. In the first, some kind of preconcentration procedure, usually cryogenic, is used to obtain a sufficiently large N_2O sample for analysis via gas chromatography/thermal conductivity detection (Weiss and Craig, 1976; Kramlich et al., 1982; Roby and Bowman, 1987). The second technique involves gas chromatography (GC) with electron capture detection (ECD). This approach is attractive because the detector is of sufficient sensitivity that a preconcentration step is not necessary (Pierotti and Rasmussen, 1976; Weiss, 1981; Hao, 1986). This paper outlines the approach and procedures used at EER to measure N_2O via GC-ECD. 6 refs., 3 figs.

24440 (DOE/PC/70782—8) **electron spin mapping of coal molecular structure by ENDOR [Electron-nuclear double resonance]: Quarterly technical progress report.** Belford, R.L. (Illinois Univ., Urbana (USA)). 15 Jul 1986. Contract FG22-84PC70782. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008374.

The general goal of this research project is the elucidation of atomic and molecular structure of coal by non-destructive magnetic resonance techniques. This report is the annual report after two years of this grant, and the investigators present a general survey of the most important work they have thus far carried out. They discuss the progress of their research on coal characterization by advanced techniques, e.g., multifrequency EPR, frequency-optimized ESE (electron spin echo spectroscopy) and ENDOR (electron-nuclear double resonance). Their work involves the development of new methodology and the application of both the newly-developed and established methods to characterize whole coals and their separated components, coal liquefaction products, synthetic coals, and model compounds. 25 refs., 13 figs.

24441 (DOE/PC/70798—T6) **Weathering effects on structure and reactivity of US coals: Third quarterly report.** Meuzelaar, H.L.C.; Hill, G.R. (Utah Univ., Salt Lake City (USA). Biomaterials Profiling Center). 1986. Contract FG22-84PC70798. 28p. NTIS, PC A03/MF A01. File Number DE86015845.

Three Western coals of different rank (Wyodak lignite, Adaville subbit. and Hiawatha hvBb) and an Interior Province coal (Upper Freeport hvAb) were air oxidized at 100°C in fixed bed, (glass walled) reactors to determine the precise mass balance during mild oxidation processes. Oxygen consumption rates and CO_2 and H_2O production rates were monitored by gas chromatography (GC) of the reactor effluent gases whereas the weight changes due to weathering were determined by repetitive weighing of the reactors containing the coal samples. To prevent the condensation of water vapor while the effluent gas was flowing through the reactor to the GC column, a heating system between the weathering oven and the GC oven was added. Subsequent GC analysis results of water vapor concentrations proved to be quite reproducible. The initial results of the material balance studies show that the mass balance can not be closed by taking into account O_2 uptake and CO_2 and H_2O losses only. In fact, a variety of volatile organic compounds were found to accompany the flue gas from the reactor, so that a cold trap was installed to trap these organic substances ranging from cyclic sesquiterpenes (Wyojak) and aliphatic hydrocarbons (all coals) to aromatic hydrocarbons (Upper Freeport, Wiawatha) and phenols (Adaville). 4 refs., 15 figs., 2 tabs.

24442 (DOE/PC/80510—6) **Liquid chromatography/electrochemistry for coal analysis: Quarterly progress report for period of December 16, 1986-March 15, 1987.** Nieman, T.A. (Illinois Univ., Urbana (USA). Dept. of Chemistry). 1987. Contract FG22-85PC80510. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008185.

This work uses liquid chromatography with electrochemical detection to identify and quantitate electroactive species extractable from coal. During this period, an Illinois coal sample, which is reported to contain 2.6% organic sulfur, was extracted under the following three conditions: 100% pyridine, at 110C; 80% DMSO/20% water, at 50C; and 100% methylene chloride, at 25C. All HPLC separations were done in reversed phase mode on a Partisil 10 μm ODS 2 column. The injected volume was 20 μL; the mobile phase flow rate was 1 mL per minute; separations were done at room temperature. Two different mobile phases were employed: 0.1 M pH 4 acetate buffer with 1% methanol; and 50% acetonitrile/50% water with 0.1 M KCl. Electrochemical detection was employed, using a potentiostat for fixed potential work and a coulostat for potential scanning work. In both cases, the electrodes used were: glassy carbon working, Ag/AgCl reference, and stainless steel counter. Results are discussed.

24443 (DOE/PC/90502—2) **Catalyst accessibility in high volatile bituminous coal: Quarterly report.** Kispert, L.D. (Alabama Univ., University (USA). Dept. of Chemistry). Apr 1987. Contract FG22-86PC90502. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008001.

It is the aim of this research to determine catalyst accessibility and the possible formation of hydrogen bonds in swellable pores of bituminous coal samples after the samples have been subjected to swelling by appropriate solvents, temperature variation and extraction with various acids or bases. To achieve this goal, we are making use of an EPR technique recently developed in this lab involving nitroxide spin probes of different sizes, shapes and sites for hydrogen bonding. Initially we incorporated nitroxide spin probes in the swellable pores of high volatile bituminous (hvb) Alabama coal from the Mary Lee (MRI), Black Creek (MRI), and Illinois No. 5 (PSOC-669) seam at ambient pressures and at temperatures of 50 to 60°C using toluene as the swelling solvent. Spin probes have also been incorporated this quarter into Illinois No. 6 (hv bituminous) coal from the premium coal sample program at Argonne National Laboratory. In addition coal from these seams have been preswelled in quinoline to remove acidic moieties and in acetic acid to remove basic moieties and then swelled in a millimolar toluene solution of spin probe IV to determine the relative ratio of the remaining swellable acidic sites. The new computer programs to permit on-line analysis of the EPR spectra mentioned in our last report, have now been developed and tested. Development of the computer programs has taken longer than anticipated and thus we have been unable to prepare high molecular weight spin probes using low molecular weight polymers as suggested in our January report. The difficulty with proper computer analysis of the EPR spectra of coal samples containing spin probes is the interference of the large EPR signal from coal with the weak EPR signals from the nitroxide spin probe. A satisfactory analysis method has now been developed.

24444 (DOE/PC/90504—T2) **Configurational diffusion of coal macromolecules: Quarterly progress report, December 15, 1986 to March 15, 1987.** Guin, J.A.; Curtis, C.W.; Tarrer, A.R. (Auburn Univ., AL (USA). Coal Conversion Lab.). 1987. Contract FG22-86PC90504. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007536.

The objective is to investigate the phenomenon of hindered diffusion of coal macromolecules in idealized porous media. There are five tasks for this program: (1) to construct a diffusion cell with ideal pore structure for determination; (2) to prepare and characterize ideal porous membranes; (3) to perform model compound experiments to calibrate and test diffusion apparatus and methodology; (4) to prepare and characterize coal macromolecules; and (5) to analyze data to evaluate the diffusional behavior of coal macromolecules. This quarter work has centered on: (1) constructing the diffusion cell; (2) simulation of material balance performance of the diffusion cell; and (3) investigation of Al_2O_3 membranes prepared by anodization of Al. 12 refs., 5 figs.

24445 **(DOE/PC/90507—T2) Surface properties of coal and their role in coal beneficiation: Technical progress report, 15 December 1986 to 14 March 1987.** Fuerstenau, D.W. (California Univ., Berkeley (USA). Coll. of Engineering). Apr 1987. Contract FG22-86PC90507. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008055.

The main focus of the research is to delineate the wetting characteristics of coal in relation to fine coal processing. As both bulk and surface properties are interrelated and have a controlling role on the performance of these processes, a detailed study was undertaken to correlate their influence on the wetting behavior and response of coal to flotation. In the previous quarterly report, the results of preliminary studies on the effect of temperature and time of oxidation on the film flotation response of two coal samples, namely Cambria No. 78 (Pennsylvania low-volatile bituminous) and Dave Johnston (a Wyoming subbituminous) was discussed. Because of the generation of oxygenated functional groups, the coal surface is rendered more hydrophilic as the temperature or the time of oxidation was increased. Research work during the past quarter involved continued characterization of the coals subjected to various degrees of thermal oxidation. The mean wetting tension, as obtained from film flotation experiments, of a number of as-received and oxidized coals of different ranks was correlated with the oxidation temperature and the oxygen content. In addition, the susceptibility to oxidation of the fifteen different coals which had been studied previously was also quantified in terms of oxygen uptake. The results are analyzed in terms of coal carbon content, oxygen content and response to vacuum flotation in salt solution. 8 refs., 12 figs., 2 tabs.

24446 **(DOE/PC/90519—T1) Electrochemical characterization and derivatization of coal: Technical progress report, December 15, 1986-March 15, 1987.** Park, S.M. (New Mexico Univ., Albuquerque (USA). Dept. of Chemistry). 1987. Contract FG22-86PC90519. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006751.

A theoretical study of the chronopotentiometric response for regeneration mechanisms at an electrode expanding with any power law by using a programmed current of the form $I(t) = I_0t$/sup q/ is presented. These equations are valid both for a stationary electrode and for a dropping mercury electrode if the expanding plane electrode model is adopted. In addition, the sphericity of the dme has also been taken into account by adopting the more rigorous expanding sphere electrode model. Characteristics of the potential-time curves and procedures to determine the rate constant of the chemical reaction are shown. If the regeneration fraction, p, is <1, a transition time, tau, is always obtained. However, for $p \geqq 1$ transition times are not always observed. Conditions for this case are discussed. 24 refs., 13 figs.

24447 **(DOE/PC/90521—T2) Role of porosity in supercritical fluid extraction of coal: Technical progress report.** Bale, H.D. (North Dakota Univ., Grand Forks (USA). Dept. of Physics). 15 Apr 1987. Contract FG22-86PC90521. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008300.

Our studies of supercritical extraction from coal entail two experimental approaches. Changes in the porosity of the coal brought on by the extraction process will be studied by small angle x-ray scattering at the UND Physics Department and the analysis of extract composition will be carried out at the UND Energy Research Center. At this time we are still in the equipment testing and development stage. This brief report points out some of the "discoveries" and difficulties that our tests have revealed and also discusses the necessary changes that we have made in order to deal with the problem areas.

24448 **(DOE/PC/90959—T1) Microscopic modeling of sound waves in granular material: Quarterly progress report, 1/1/87-3/31/87.** Haff, P.K. (California Inst. of Tech., Pasadena (USA)). 1987. Contract FG22-86PC90959. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007400.

As a preliminary to the study of sound waves themselves, we have looked at test cases of particles contained within vibrating boxes. The vibration amplitudes were larger than would occur in most sound-wave problems, but observed particle behavior could be compared against behavior seen in similar calculations performed with a completely independent particle-dynamics code [Haff and Werner, 1986]. These comparisons provide one line of argument supporting the notion that the present code is correctly computing the motion of particles in the presence of an external energy source. Some comparisons have also been made against particle motion observed in the laboratory in a two-dimensional shaking box, with satisfactory agreement. A one-dimensional array of particles is being constructed which will be driven acoustically with a piezoelectric transducer. This will allow us to compare code predictions with one of the simplest possible particle configurations capable of transmitting acoustic waves. These and similar comparisons will also allow a calibration of the simulation model, and will help us determine allowable ranges of material "constants" which cannot otherwise easily be pinned down. We will begin some simple acoustic simulations in which a sample of ~ 100 particles is enclosed in a container at known pressure and a periodic elastic wave signal is fed into the system at one boundary and detected at another. This simple system will suffice for preliminary studies of the effects on wave speeds and attenuation of external variables such as pressure, and internal variables, such as grain properties, packing-geometry, and so forth.

24449 **(DOE/PC/90960—3) Rheology of high concentration polymodal multiphase flows: Quarterly report.** Probstein, R.F. (Massachusetts Inst. of Tech., Cambridge (USA)). Apr 1987. Contract FG22-86PC90960. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008417.

In the final report for Grant DOE-FG22-84PC 70061, measured relative viscosity versus shear rate curves were presented for colloidal coal suspensions of different volume fractions. During the last quarter these results plus additional colloidal coal measurements obtained during the quarter were compared in the high-shear rate limit with high-shear rate viscosity data reported in the literature for monodisperse colloidal spherical particles. 2 refs., 4 figs.

24450 **(KEMA-SO—86-1100) A preliminary standard leaching test for polycyclic aromatic hydrocarbons from combustion residues into water.** Kanij, J.B. (Keuring van Electrotechnische Materialen N.V., Arnhem (Netherlands)). Jan 1986. 34p. (In Dutch). Divisie Onderzoek en Ontwikkeling KEMA, P.O. Box 9035, 8600 ET Arnhem, Netherlands.

The report describes a preluminary standard leaching test developed by the SOSUV group (=study group for the development of a standard test on leaching of combustion residues) to assess the amount of polycyclic aromatic hydrocarbons which is desorbed from combustion residues, specifically coal ash, into water. The study has been partially performed under contract with the management office for energy research, PEO, within the framework of the National Coal Programme, which is financed by the Ministry of Economic Affairs. 8 tabs., 9 refs., 4 app.

24451 **(NP—7770080) Physical and chemical techniques for a structural analysis of organic and inorganic coal substances.** Walter, M. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 11 Mar 1985. 185p. (In German). NTIS (US Sales Only), PC A09. File Number DE87770080.

Five typical German coal grades were investigated using ESCA, AES, and dynamic and static SIMS in order to obtain information on the advantages, drawbacks, and systematic errors of these techniques as well as on the ways in which these errors can be remedied. For the first time ever, a systematic analysis was made of the error sources resulting from the complex organic, inorganic, and organometallic structure of the coal samples. Future fields of application are pointed out. The author is sure that surface analysis techniques will soon be applied to processes such as oxidation, gasification, liquefaction, preparation, and hydrogenation of coal.

24452 **(PNL—6159) Reconfigured, close-coupled reconfigured, and Wyodak coal integrated two-stage coal liquefaction process materials from the Wilsonville facility: Chemical and toxicological evaluation.** Wright, C.W. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1987. Contract AC06-76RL01830. 79p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007902.

This document reports the results of the chemical analysis and toxicological testing of process materials sampled during the operation of the Advanced Coal Liquefaction Research and Development Facility (Wilsonville, AL) in the reconfigured, integrated (RITSL run No. 247), the close-coupled, reconfigured, integrated (CCRITSL run No. 249), and the Wyodak coal integrated (ITSL run No. 246) two-stage liquefaction operating modes. Chemical methods of analysis included proton nuclear magnetic resonance spectroscopy, adsorption column chromatography, high resolution gas chromatography, gas chromatography/mass spectrometry, and low-voltage probe-inlet mass spectrometry. Toxicological evaluation of the process materials included a histidine reversion assay for microbial mutagenicity, an initiation/promotion assay for tumorigenicity in mouse skin, and an aquatic toxicity assay using Daphnia magna. The results of these analyses and tests are compared to the previously reported results derived from the Illinois No. 6 coal ITSL and nonintegrated two-stage liquefaction (NTSL) process materials from the Wilsonville facility. 21 refs., 13 figs., 21 tabs.

24453 **The effect of heating conditions on relative MWD's of tar species.** Freihaut, J.D.; Proscia, W.M.; Seery, D.J. (United Technologies Research Center, East Hartford, CT 06108). pp 684-703 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

A general schematic of the coal devolatilization and pyrolysis process is illustrated. The relationship of the volatiles release process to the micro-scale combustion process of a coal particle is indicated. Under moderate heating rate conditions, it has been demonstrated that the total volatiles yield is a relatively insensitive function of coal rank through the high volatile bituminous range of coals, whereas the tar component of the volatiles yield varies by a factor of three from lignites to Appalachian province high volatile bituminous coals. Heavy hydrocarbon formation, secondary reactions and evolution processes have been demonstrated as responsible for the plastic behaviour of such particles.

24454 **Factors affecting the dispersibility of carbon black and coal fine particles in liquid media.** Ayala, R.E.; Hartley, P.A.; Toor, E.W. (Dept. of Chemical Engineering, Carnegie Mellon Univ.). pp 624-632 of Proceedings of the 11th annual powder and bulk solids conference and exhibition. Des Plaines, IL; Cahners Exposition Group (1986). (CONF-8605168—).

From 11. annual powder and bulk solids conference/exhibition: powder and bulk solids handling and processing; Rosemont, IL, USA (13 May 1986).

The authors show that the factors that affect dispersibility, powder wettability and agglomerate cohesiveness, are related. Incorporation rates are controlled by the surfactant concentration level and powder cohesiveness is dominated by packing structures.

24455 **Extraction of polycyclic aromatic hydrocarbons for quantitative analysis.** Griest, W.H.; Caton, J.E. (Oak Ridge National Lab., TN). pp 95-146 of Handbook of polycyclic aromatic hydrocarbons. Bjorseth, A. (ed.). New York, NY; Marcel Dekker, Inc. (1983). Contract W-7405-ENG-26.

Efficient extraction of polycyclic aromatic hydrocarbons (PAH) from the sample matrix is a crucial step in the preparation of a sample for PAH determination, yet it is one of the least appreciated steps. All too often, semistandardized extraction procedures are employed with little apparent regard for extraction recoveries of the PAH. Obviously, incomplete extraction without provisions for extraction recovery corrections will lead to a low bias in the analytical data. In the case of an exemplary highly sorptive matrix such as coal fly ash, extraction recoveries of some PAH can be as low as 10%, leading to an order-of-magnitude underestimation in PAH concentrations if the recoveries are not determined. Numerous review papers of the determination of PAH in various matrices have included short sections on PAH extraction, but few, if any, reviews appear to concern PAH extraction alone. The purpose of this chapter is to critically review the more widely used PAH extraction procedures reported over the last 10 to 15 years. This is not a comprehensive review in that it is impractical to cite each and every paper employing a PAH extraction of some type. Rather, the review is restricted in scope to the more prominent and important reports which would contribute to a critical comparison of PAH extraction procedures without being overly redundant. The attention allotted to each extraction procedure is roughly proportionate to its usage in the open literature. 174 references, 10 tables.

0108 Waste Management

REFER ALSO TO CITATION(S) 24397, 24438, 24600, 24775, 24779, 25779, 25829

24456 **(DOE/FE/60181—115) Additive enhancement of pressure-hydrated lime for control of SO_2/NO/sub x/ emissions.** Bobman, M.H.; Weber, G.F.; Keener, T.C. (North Dakota Univ., Grand Forks (USA). Energy Research Center). Mar 1985. Contract FC21-83FE60181. 23p. (CONF-850357—6). NTIS, PC A02/MF A01. File Number DE87008020.

From Spring national meeting of AIChE; Houston, TX, USA (24 Mar 1985).

Control of SO_2/NO/sub x/ emissions from low-rank coal combustion is investigated. This paper presents results from bench- and pilot-scale studies using pressure-hydrated lime and doped pressure-hydrated lime for the removal of SO_2/NO/sub x/. These results indicate that greater utilization of sorbent may be achieved through pressure-hydration. Activation energies, reaction orders, and possible rate-limiting mechanisms for the sorbent-SO_2 reactions are also presented. The reaction of SO_2 with three sorbents formed by pressure hydration of quicklime was studied using thermogravimetric analysis and pilot-scale injection into a boiler. A semi-empirical pore-plugging model was used to describe the sulfation of dehydroxylated sorbents with good correlation of predicted and measured values of conversion. Activation energies of 26.8 to 49.0 KJ/mole were observed, the latter for a sorbent doped with sodium. Pilot-scale combustion were conducted firing natural gas. Injection temperature and baghouse temperature were nominally 1270°K and 360° to 380°K, respectively. Sorbent utilization values exceeding 70% at an alkali/SO_2 mole ratio of 1.0 have been observed. Simultaneous NO/sub x/ reduction of up to 20% has been observed. 14 refs., 18 figs., 4 tabs.

24457 **(DOE/MC/21108—2191) Management of coal waste by energy recovery: mild gasification/flash pyrolysis of coal preparation wastes. Quarterly report, April-June 1986.** Chu, C.I.C.; Gillespie, B.L. (UCC Research Corp., Bristol, VA (USA)). Aug 1986. Contract AC21-84MC21108. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87000621.

Several modifications were made to the Mild Gasification Unit, MGU. Modifications included relocating the condensing system from the second floor to the third floor, modifying the condensing system to enable water-cooling or dry ice-cooling, installation of an equilibrium line between the char chute and the gas-exist lines, and mounting the condensing system on weigh scales to allow determination of the trend of hydrocarbon liquid production as a function of time. Six tests were conducted on the MGU. Four of the tests were shakedown tests while two of the tests were part of the final test plan. Different configurations were tried on the condensing system as well as different types of cooling. Various conditions were used during the tests including tests with bituminous and subbituminous coals, lime additive, and different residence times. Analytical data on the char and liquid products were received including boiling point distribution, ^{1}H-NMR, LC-NMR, and ultimate and proximate analyses.

24458 (DOE/PC/70771—T5) **Kinetics of nitrogen and sulfur reactions in combustion systems: Quarterly report No. 7.** (Energy and Environmental Research Corp., Irvine, CA (USA)). 1987. Contract AC22-84PC70771. 122p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006703.

The overall program is designed to support one goal: develop the crucial fundamental mechanistic and quantitative rate information on the chemistry of formation and control of sulfur and nitrogen oxides as they pertain to pulverized coal fired systems. Because this area is so broad, the activity is focused somewhat on viable emerging control technologies. These technologies are specifically: NO/sub x/ control: staged combustion, reburning (fuel staging) and sorbents for NO/sub x/ capture. SO/sub x/ control: calcium-based sorbents, low-temperature sorbents, and additives and preprocessing of calcium sorbents. However, it is expected that the fundamental mechanistic data that results from investigating issues related to the specific control technologies will have much broader long-range applications. In particular, new technologies may actually arise from the mechanistic kinetics information if they identify the major fundamental limitations to existing technologies. This program is conducting a series of fundamental experiments which will be integrated by a process model. Models describing sulfur capture by sorbents and the rate of destruction of nitrogenous species in combustion products are available. What is needed and will be provided by this program are verified kinetic mechanisms for the various submodels. Once the process models are available heat/mass transfer effects and fluid dynamics must be taken into account to evaluate practical systems. The program is a teaming of efforts of several organizations, each supplying a portion of required data. The data are continually evaluated by and incorporated into kinetic models of pollution generation and control. Four parts of the report have been entered individually into EDB and ERA.

24459 (DOE/PC/70771—T5, pp 3.1-3.3) **Sorbent reactivity (EER).** 1987. NTIS, PC A06/MF A01. File Number DE87006703.

In Kinetics of nitrogen and sulfur reactions in combustion systems: Quarterly report No. 7.

One of the goals of this program is to develop a process model for in-furnace sulfur capture by calcium-based sorbents. The program has supported, in part, the development and use of three major models. These include a grain model, a distributed pore model, and a pore-tree model. A major difference between each of these models is the physical structure assumed for the sorbent. The hard data needed to characterize sorbent structure has simply not been sufficient to identify the appropriate structure to use in the model. The principal difficulty is that prior to sulfation in the furnace the raw material flash calcines to CaO, and this CaO undergoes a rapid sulfation reaction. Data suggest that the CaO so produced undergoes a rapid sintering step in the presence of water and CO_2. Thus, CaO samples collected at long times (i.e., at the furnace exhaust) may not resemble the state of the CaO that actually undergoes sulfation at short times. An added problem is that collection of CaO from water laden combustion gas always involves some rehydration of the CaO during low-temperature collection. The Inert Precalciner has been proposed as a means of obtaining the structure of CaO prepared by flash calcination. The keys to the approach are: (1) Calcination at the temperatures and times associated with furnace injection. (2) Calcination in an inert environment to avoid in-furnace catalyzed sintering and sorbent sampling artifacts. A schematic of the inert calcination system is presented. The system design allows calcination of calcium-based sorbents in an entrained flow environment under inert and isothermal conditions. Nitrogen or another gas such as air or simulated combustion products are preheated, then mixed with the sorbent at the entrance to the calcination chamber.

24460 (DOE/PC/70771—T5, pp 5.1-5.94) **Alternative SO_2 sorbents: Quarterly progress report, 1 November 1986-31 January 1987.** Simons, G.A.; Ham, D.O.; Parker, T.E.; Morency, J.R.; Moniz, G.; Boni, A.A. (Physical Sciences Inc., Andover, MA). 1987. NTIS, PC A06/MF A01. File Number DE87006703.

In Kinetics of nitrogen and sulfur reactions in combustion systems: Quarterly report No. 7.

The objective of this work is to screen potential alternative mineral sorbent candidates for use downstream from convective superheater tubes and to provide a sufficient kinetic data base for incorporation of these sorbents into process models. Screening tests of the candidate sorbents have indicated that Colton Hydrate, Trona and Shortite all give comparable results in this temperature range while promoted CH (with T) yield superior results. A sorbent model has been developed which includes the pore structure, pore branching, species transport, reaction kinetics, product deposition, pore filling, pore plugging and diffusion through the product layer. The model has been validated with both surface area evolution data (BET data) and sulfation data in the temperature range 973 K to 1478 K. The intrinsic rate constant has been evaluated to within a factor of two and the model has been used to infer the product layer diffusion coefficient in the 1000 K to 1400 K temperature range. The model has clearly delineated the roles of pore plugging, pore filling, reaction kinetics, and product layer diffusion in controlling sulfation. The model has been exercised to demonstrate that the SO_2 pressure and the particle temperature, surface area and porosity are the most important factors controlling sulfation. The calcination model predicts that the particle size is also important, in that it strongly influences the surface area of the calcine. Application of this model to entrained flow data allows us to reduce the data to such fundamentals as to determine the most promising sorbent for optimum SO_2 removal. 57 refs., 32 figs., 2 tabs.

24461 (PB—87-144663/XAB) **Abandoned mine lands: a mid-course review of the national reclamation program for coal. Final report.** (National Academy of Sciences, Washington, DC (USA). Commission on Physical Sciences, Mathematics, and Resources). Nov 1986. 244p. NTIS, PC A11/MF A01.

The Committee on Abandoned Mine Lands (CAML) analyzed how the U.S. Department of the Interior's (DOI) Office of Surface Mining (OSM) has and is administering the Title IV (Abandoned Mine Lands) Program of the Surface Mining Control and Reclamation Act of 1977. In the course of focusing on the effectiveness of the program, the Committee evaluated the program not only in terms of its probable accomplishments over its fifteen-year life, between 1977 and 1992, when the program statutorily ends, but also the magnitude and nature of the AML problems remaining to be remedied in the post-1992 period, if Congress decides to extend it. The Committee made nineteen recommendations about how OSM could improve the AML program's current effectiveness as well as prepare to assist Congress in reaching a decision to terminate or extend the program. Over the fifteen-year life of the program, some $3.3 billion will have been spent.

24462 **Solid collectors for the control of emissions.** Klinzing, G.E.; Blachere, J.R.; Weintraub, M.; Shannon, S.; Martello, D. (Univ. of Pittsburgh, School of Engineering, 1249 Benedum Hall, Pittsburgh, PA 15261). pp 938-950 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

Sodium adsorption from coal flue gas has been demonstrated in a laboratory scale combustion system by co-injection of adsorbent particles with the coal fuel. Effects of adsorbent pretreatment and certain combustion conditions on sodium adsorption have been determined for activated alumina and emathlite clay. Porous glass has similar affinity for sodium. Isothermal experiments in a controlled furnace will clarify effects of temperature and pore structure on sodium adsorption.

0109 Environmental Aspects

REFER ALSO TO CITATION(S) 24418, 24419, 24455, 25844

24463 (TNO-HMT—85-0365A) Measures against fugitive coal dust during storage and trans-shipment of coal. Part 1: Evaluation of abatement techniques. Eggels, P.G. (Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands)). Mar 1985. 164p. (In Dutch). Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands.

This study forms the first part out of three of an evaluation of fugitive dust abatement techniques arising from the storage and handling of coal in The Netherlands. This part covers a study of factors and mechanisms determining the effectiveness and the application possibility of dust-control techniques. Techniques to be described in more detail are the spraying/catching of dispersed dust, the spraying of the bulk material, the screening-off of the dust source and the application of process modifications. The important influence on dust emission appears of some material properties as the extent of the silt content, the porosity of the coal and the free moisture-content. Important criteria in evaluating the abatement techniques are process factors and financial aspects. The results of the evaluation have produced the following points of view: the application of crust-forming agents to the surfaces of coal heaps, as protection against long-term exposure to wind erosion, offers a reduction in the emissions and a better conservation of the calorific value; emitted-dust entrapment by means of a 'dry' water-mist shows attractive perspectives when combined with a partial enclosure of the dust source; in addition to a reduction in dust emission the application of change of process also offers a number of technological advantages, examples hereof are applications of continuous discharging/unloading equipment, large-scale walled storage and small-scale silo storage. The question as to which dust control techniques are to be preferred in a specific situation can be answered for the greater part with the information gathered and evaluated in this desk study. The points where additional research is essential are being inventorised.

24464 (TNO-HMT—85-03657B) Measures against fugitive coal dust during storage and trans-shipment of coal. Part 2: Assessment of the Dutch situation. Eggels, P.G. (Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands)). Oct 1985. 35p. (In Dutch). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751766.

This study forms the second part of an evaluation concerning measures to control fugitive dust at coal storage and trans-shipment facilities in The Netherlands, and comprises an assessment of the Dutch situation with regard to coal dust control. A sufficiently large moisture content of the coal seems to guarantee a conclusive safeguard against coal dust emission but in The Netherlands no unanimity is found with regard to the required minimum of free moisture content of the coal. Besides, a number of companies lack the facilities to humidify the coal to a sufficient degree. The Dutch situation certainly needs to be improved on these points. It is, however, unclear whether the concept for dust control as it is being managed in The Netherlands, is in fact superior, from a financial and environmental point of view, to the concept that starts from improved screening of the emission sources, without a further increasing/decreasing of the moisture content of the coal. A comparison of the way dust is being controlled indicates that differences exist in the degree to which companies apply techniques to control dust at similar sources. Much attention is generally paid to reduction in emissions concerning hoppers, storage heaps and traffic, a state of affairs that is in keeping with the relative importance of these sources of dust at Dutch coal storage facilities.

24465 (TNO-HMT—85-03657C) Measures against fugitive coal dust during storage and trans-shipment of coal. Part 3: Evaluation of three facilities with different scale of coal handling. Eggels, P.G. (Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands)). Oct 1985. 60p. (In Dutch). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751767.

For three fictitious facilities with different scale of coal handling emission rates, effectiveness of control measures and their respective costs have been calculated. Emission factors, process performance and climatology have been taken into account. At the same time, indicative calculations concerning the spreading of dust have been executed for a single scale size. The full emission rate at a coal terminal (output 6 x 10/sup 6/ tonnes of coal per annum) will amount to 420 tonnes of dust per annum if control measures are not applied. With the aid of measures that are already in many cases being applied in practice, dust emission at the terminal will be reduced to 29 tonnes per annum, which requires Dfl. 12 for each kg of reduced dust. Coal storage at a power station (consumption 1.5 x 10/sup 6/ tonnes per annum) will cause 75 tonnes of dust emission per annum. Commonly applied measures will reduce this emission to 5-6 tonnes per annum for Dfl. 17 for each kg of dust emission reduced. An emerging dust emission at a small-scale consumer (consumption 10/sup 4/ tonnes per annum) will be a relatively small one and amount to a good 300 kg per annum, as against approximately 51 kg of dust emission per annum if measures to control dust are being applied. This reduction in emission at a small-scale consumer will require Dfl. 64 for each kg of dust emission reduced. Spreading of dust and the consequences of a stringent reduction in emission have been worked out for the coal depot of the station. A further reduction in dust emission will be very expensive and requires, on average, at least Dfl. 900 for each kg of reduced dust emission.

24466 (TVA/ONRED/LER—86/59) Ecological recovery after reclamation of toxic spoils left by coal surface mining: Phase 2, An assessment of environmental changes following intensive remedial treatments. Zarger, T.G.; Scanlon, D.H.; Nicholson, C.P.; Brown, S.R.; Starnes, L.B.; Harned, W.D. (Tennessee Valley Authority, Norris (USA)). [1987]. 142p. NTIS, PC A07/MF A01. File Number DE87900612.

This study involves a selected watershed in which surface mining and unsuccessful reclamation efforts in the early 1970's resulted in adverse environmental impacts. Work on the east Tennessee problem mine sought to correct reclamation deficiencies by applying land stabilization treatments and then to evaluate their effectiveness by measuring the degree of recovery of the affected terrestrial and aquatic ecosystems. Conditions documented during the mining and reclamation, and those following restorative treatments, provide a measure of ecological recovery. Evaluations on environmental effects cover vegetation, soils, water quality, aquatic macroinvertebrates, fish, small mammals, birds, and sedimentation.

24467 Condensation feedback mechanism for oscillatory nucleation and growth. McGraw, R.; Saunders, J.H. (Brookhaven National Lab., Upton, NY). *Aerosol Science and Technology;* 367-380(1984). Contract AC02-76CH00016.

The competition between nucleation and condensation on new particle surfaces is shown to provide an effective control mechanisms capable of regulating the dynamics, size, and number density of particles formed through gas-to-particle conversion. Calculations are presented for a continuous stirred tank aerosol reactor (CSTR) under conditions approximating coal-gas aerosol and atmospheric particle formation. A linearized normal mode analysis is used to obtain a complete stability diagram for the system, and both stable and unstable regimes of operation are found. An expression for the period of marginal oscillation at the boundary between these regimes is obtained. Computer simulations for the evolution of particle number and particle surface area densities are presented for representative operating conditions in the stable, marginally stable, and unstable condition regimes. In the unstable regime, sustained limit-cycle oscillations in particle size and number density are found. Each of these effects is traced to nonlinearity inherent in the classical description of evaporation and growth. 23 references, 7 figures.

0110 Reserves And Exploration

REFER ALSO TO CITATION(S) 24395

24468 (NMRDI—2-74-4629) Assessment of technological development strategies for San Juan Basin coals: Final technical report. (Sinor (J.E.) Consultants, Inc., Niwot, CO (USA)). Feb 1987. 700p. NTIS, PC A99/MF A01 - New Mexico Research and Development Institute, Suite 358, 1220 S. St. Francis Dr., Santa Fe, NM 87501. File Number DE87900631.

An analysis of potential future markets for San Juan basin coal and coal products covered coal, beneficiated coal, synthetic fuels from coal, and mineral products from coal ash. A transportation analysis was also completed, and used to calculate netback product values at a plant site in the San Juan basin. An economic screening analysis was carried out for processes identified as having economic potential. The best of these were then subjected to economic risk analysis. An overall development strategy was constructed with short-term, mid-term and long-term components. Approximate costs and benefits to the State of New Mexico were estimated for each of the recommended projects. 70 refs., 61 figs., 182 tabs.

24469 Occurrence of detrital mineral matter in Okefenokee peats. Andrejko, M.J.; Raymond, R. Jr. (Univ. of South Carolina, Columbia). pp 19-21 of Microbeam analysis. Gooley, R. (ed.). San Francisco, CA; San Francisco Press, Inc. (1983). Contract W-7405-ENG-36.

Peat, the precursor of coal, is predominantly composed of partially decomposed plant debris along with varying amounts of inorganic material. This inorganic matter (often referred to as ash) consists of a mixture of distinct mineral species and ionically bound or complexed inorganic compounds. The composition of this inorganic fraction is controlled by a variety of botanical and depositional environments and processes. The peats used in this study are from the Okefenokee Swamp, a low-sulfur, exclusively fresh-water analog of an ancient coal-forming environment. Unlike other peat deposits, the inorganic fraction of Okefenokee peats is primarily composed of silica, most of which consists of biologically derived, authigenic particles. However, the peats do contain nonbiogenic mineral particles of both a silica and nonsilica composition. Our purpose was to determine grain textures and elemental compositions of the nonbiogenic particles through use of scanning electron microscopy (SEM) and energy-dispersive x-ray (EDX) analysis. Analytical results indicate that many of these mineral particles are detrital in origin.

0120 Mining

REFER ALSO TO CITATION(S) 24468, 24498, 24500

24470 (DOE/METC—87/0251) Coalbed methane: Technology status report. (USDOE Morgantown Energy Technology Center, WV). Jan 1987. 22p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87001032.

Coalbed methane research focuses on (1) estimating the extent of the resource with increased accuracy and reliability, (2) estimating the amount of coalbed methane that is recoverable, and (3) providing technically and economically viable means for methane recovery. The goal is to promote extensive private and public use of the resource as a national energy source. DOE has made significant progress in developing new knowledge, including the following accomplishments: Over 90 well sites have been logged, and over 350 core samples have been taken from these sites for desorption and proximate and ultimate analysis tests to provide insight into gas release mechanisms for various coal ranks. A comprehensive geological assessment was made to estimate the gas-in-place for 16 basins. Twenty production tests were completed to develop guidelines for recovery concepts in different geologic environments. While the project has made significant progress, the development of coalbed methane as a contributing source to the US gas supply has not been widespread. The mixing of unconventional gas with conventional natural gas has been investigated for use by residential, municipal, commercial, and industrial customers in space heating, coal drying, and onsite power generation. However, the risks and economics associated with recovery concepts in basins other than the Warrior basin sre still lacking. 5 refs., 11 figs.

24471 (NP—7770077) Transport of pipes and rails in coal mines. Technical and economic comparison between conventional transport techniques and transport using HF equipment. Wallrich, M. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 31 Jul 1985. 130p. (In German). NTIS (US Sales Only), PC A07. File Number DE87770077.

Transport and handling of long pipes and rails is greatly facilitated by a new HF transport system. The author analyses the performance and economics of the system. Shorter haulage times, higher transport capacities of the overhead monorail system, and a lower susceptibility to accidents are the main advantages of the system. The costs are based on operating cost calculations. HF equipment is found to reduce the costs of mine transport. (HLN).

24472 (NP—7770082) Status report on coal mine projecting and project evaluation standards. Schnur, H. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 3 Jan 1985. 210p. (In German). NTIS (US Sales Only), PC A10/MF A01. File Number DE87770082.

The layout of modern coal mines is analyzed, and parameters for mine efficiency analysis are defined and calculated. The analyses were made in Ruhr coal mines. The main criterion of assessment is the function of shafts and their location across the deposit. Floors are another important element; they are analyzed as a function of their layout and function. Characteristic data are presented by which mines can be analyzed on the basis of cost calculations and a cost-benefit analysis. (HLN).

24473 (NP—7770083) Heat and moisture transfer from run-of-mine coal to the air flow. Schlotte, W. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen). 12 Jul 1985. 130p. (In German). NTIS (US Sales Only), MF A01. File Number DE87770083.

Heat and moisture transfer from coal to air was investigated as a function of climate, air flow rate, and coal temperature. The data were processed by computer to obtain a calculation model. The experiments were made in a climate laboratory using run-of-mine coal from different seams. The measured and calculated results are presented in diagrams. The model improves forecasting of mine climates. (HLN).

24474 (PB—87-138806/XAB) Evaluation of mine-stopping sealants and squeeze blocks. Open File report, October 1979-April 1984. Marshall, M.D. (MSA Research Corp., Evans City, PA (USA)). Aug 1986. 78p. (MSAR—86-35). NTIS, PC A05/MF A01.

A survey and test program was conducted to establish from materials now in use or available the best sealants for concrete-block stoppings and the value of squeeze blocks for stoppings with mine convergence. Mines were surveyed for sealants currently used, and commercial products were surveyed for new sealant materials. An in-mine evaluation showed that, within limits, poor stopping construction practices rather than sealants were the cause of leakage. Sealants were found that could be brushed on concrete block rather than trowelled to produce stoppings twice the strength of mortared joint stoppings, and equal in strength to dry-stacked stoppings, both standard construction techniques. The brush-on technique and improved construction practices were proved on demonstration stoppings tested over a period of 1 year and are now recommended by the Bureau of Mines in a new handbook. Polystyrene boardstock was the most commonly used material for squeeze blocks and was considered by mines using squeeze blocks to be helpful in maintaining stopping integrity under mine-convergence conditions. Alternative squeeze block materials with overall properties better than polystyrene were found.

24475 **(PB—87-139580/XAB) Measurement of coal-cutting forces underground with the in-seam tester. Report of investigations/1986.** Sundae, L.S. (Bureau of Mines, Twin Cities, MN (USA). Twin Cities Research Center). 1986. 24p. (BM-RI—9033). NTIS, PC A02/MF A01.

Library of Congress catalog card no. 85-600289.

The Bureau of Mines designed, fabricated, and is using an in-seam tester for in-situ determination of coal-cutting forces. The report describes the results of field tests conducted in the Pocahontas No. 3 and Upper Freeport seams to obtain peak and mean cutting forces during coal cutting with several bit geometries, including radial and point attack bits currently used on drum-type machines. Comparisons were also made between new and worn bits, and by using data obtained from a Bureau-modified chisel bit. The test results show that longwall plough cutting (horizontal cuts) in bony coal bands (shale) requires greater than three times the cutting force for the same cuts in a vertical direction. When no bony coal is present, the cutting forces required to make horizontal and vertical cuts are equal. Worn bits require four to five times more cutting and normal force than new or undamaged bits. Normal force increased drastically for the worn chisel bit. Peak force encountered in making independent cuts was found to be approximately three times higher than that required to make interactive cuts using a spacing-to-depth-of-cut ratio of 2. Both rake and clearance angles were found to have a significant effect on normal and cutting force.

0130 Transport And Handling

REFER ALSO TO CITATION(S) 24491, 25166

24476 **(DOE/PC/90578—1) Aerated and vibrated chute feeders for particulate materials: Quarterly technical report for the period 12/1/86 to 2/28/87.** Jackson, R. (Princeton Univ., NJ (USA). Dept. of Chemical Engineering). 1987. Contract FG22-86PC90578. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007398.

In continuation of our effort to study the gravity flow of particulate materials in inclined chutes, we investigate the effects of aeration and vibration on the performance of the chutes, in the belief that it is enhanced by the addition of these two processes. In this report, we have formulated the equations of motion and boundary conditions that describe this system. We intend to solve the resulting differential equations and compare the performance of this system with that of chute flow in the absence of aeration and vibration. 8 refs., 5 figs., 2 tabs.

24477 (NP—7751733, pp 1-16) **Coke.** Strunk, G. 1982. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751733.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.3. Energy distribution.

In the framework of a comparative study on the use of alternative energy sources in the Rhine and Neckar region, this paper reports on the distribution of black-coal coke to households and analyses the cost. Waterways are the routes for transporting the fuel from the mining area to the wholesalers' stores. Cost in the end-distribution sector is sub-divided as follows: storage and turnover cost, export cost (factors of influence: supply quantity, transport volume, export type, shipping distance to customer), sales and administration cost as well as cost from the calculation point of view (entrepreneurial wages, capital interest, risk surcharges). These individual types of cost are dealt with in detail, which includes figures given as hints regarding calculation formulas and their variables. Results of calculations of distribution cost for certain settlement types (ST 1..9) are grouped as to calculation parameters, and presented in several tables and histograms. (HWJ).

24478 (NP—7751733, pp 1-17) **Comparing natural gas, district heating, heating fuel oil and coke for various types of settlements.** Strunk, G. 1982. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751733.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.3. Energy distribution.

To conclude investigation regardings the possibility of meeting energy demand by energy sources other than heating oil in the Rhine and Neckar region, a system comparison (space heating, water heating) of natural gas, district heat, EL heating oil and black-coal coke was carried through for certain settlement types. The comparison served to establish and prepare diagrams on the specific cost of distributing line-transmitted energies as a function of maximum-performance heat density (district heat of conventional installation type, flat installation; natural-gas transmission line installation to settlement types ST 1 ... 9: to existing settlement area, as well as joint transmission line with gas and drinking water conduit). Furthermore the annual costs of natural gas and district heat distribution are summed up in tables, further comparative diagrams indicate the annual distribution costs for the four energy sources mentioned at the beginning. Hints are given as to zones of climate, ventilation heat losses, thermal protection, heat transition coefficients and pumping energy demand. Finally figure examples are given for performance-specific and annual costs. (HWJ).

0140 Combustion

REFER ALSO TO CITATION(S) 25154, 25427

24479 **(ANL—87-11) Atmospheric fluidized-bed cogeneration air heater experiment: 1000-h Laboratory Test A.** Natesan, K.; Podolski, W. (Argonne National Lab., IL (USA)). Mar 1987. Contract W-31109-ENG-38. 47p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007955.

A laboratory test program is described to evaluate the corrosion behavior of several metallic alloys, coatings, claddings, and weldments in support of the atmospheric fluidized-bed air heater experiment. Results are presented from the first 1000-h test (Test A) conducted at metal and gas temperatures of 871 and 899°C, respectively. Detailed information is also presented on the corrosion scale morphologies, scale compositions and thicknesses, intergranular penetration of the substrate material, and metal recession.

24480 **(CONF-861211—18) Influence of solids hydrodynamics on local heat transfer from tube banks immersed in a gas fluidized bed.** Moslemian, D.; Chen, M.M.; Chao, B.T. (Illinois Univ., Urbana (USA). Dept. of Mechanical and Industrial Engineering). 1986. Contract FG22-85PC80511. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87000863.

From American Society of Mechanical Engineers winter meeting; Anaheim, CA, USA (7 Dec 1986).

Fluidized bed combustion (FBC) has generated considerable interest as an efficient low-cost and non-polluting means of burning a variety of fuels. Despite the research and developmental efforts focused on FBC for more than three decades, the current state-of-the-art remains at a distance from the point where the combustor/boiler performance can be predicted with confidence. The high heat transfer rates and small internal temperature gradients as perceived from efficient mixing have yet to be fully realized. This is due largely to the multiplicity of variables involved in a fluidized bed combustor and the complexity of its hydrodynamics. Many empirical correlations for predicting heat transfer between a gas fluidized bed and the immersed internals have been proposed. They are based mainly on gross experimental observations with minimal attention to the mechanism of heat transfer due, at least in part, to the lack of systematic data on solids motion. Much useful insight can be obtained from a simultaneous determination of the local heat transfer rates from immersed internal structures and the associated hydrodynamics of the solid particles. Accordingly, in this study, the local mean heat transfer coefficients of horizontal internals simulating tube banks were measured for several locations in the bed along with measurements of the mean solids velocity and density distributions for a range of superficial gas velocities. The experiments were conducted in a 184 mm (7.25 in.) ID air fluidized bed with a horizontal in-line internal rod bundle of 16 mm (0.625 in.) OD with pitch-to-diameter ratio of 4 over a wide range of gas velocities. The results showed that the local heat transfer rates depend strongly on the flow pattern of solids induced by the bubble motion. The data confirmed the expectation that particle convection plays a major role in the mechanisms of heat transfer from immersed internals. 15 refs., 12 figs., 2 tabs.

24481 (CONF-8604156—, pp 117-126) **Recent developments in physical flow modeling of utility scale furnaces.** Anderson, D.K.; Bianca, J.D.; McGowan, J.G. (Combustion Engineering, Inc., Windsor, CT). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

This paper summarizes recent physical flow modeling carried out at Combustion Engineering's Kreisinger Development Laboratory. Included is a review of current instrumentation, experimental facilities, and techniques for the isothermal modeling of full scale industrial furnaces. Equipment used for flow visualization, three dimensional velocity mapping, and the simulation of fuel/air mixing are discussed. A description of a new tangential-fired furnace flow model is also given. This large-scale furnace model is surrounded by an instrument traversing system which allows the placement of various instrument packages around and within the model envelope. The instruments that have been used in this facility include a multi-hole pitot tube, a laser absorption spectrophotometer, and a two-axis laser doppler anemometer. Experimental information from this model has been used to predict such important furnace parameters as slagging potential, fuel-air mixing, and fuel burnout. Other recent physical modeling experiments are discussed and include the development of a high turndown coal burner assembly, and overall furnace modeling studies for a recovery and a wood-fired boiler. 23 references, 13 figures.

24482 **(DOE/PC/70815—T8) Kinetics of coal combustion: Eighth quarterly report.** Gat, N.; Petach, M.; Gavalas, G.R.; Flagan, R.C. (TRW Space and Technology Group, Redondo Beach, CA (USA). Applied Technology Div.; California Inst. of Tech., Pasadena (USA); Ohio State Univ., Columbus (USA)). Feb 1987. Contract AC22-84PC70815. 38p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007839.

The investigation of fundamentals of coal combustion kinetics addresses several topics of major importance relative to improved understanding of pulverized coal combustion and includes both homogeneous and heterogeneous reactions. The principal topics include: (1) combustion of volatiles, and (2) heterogeneous combustion of coal/char. Research activities include small-scale experimentation, interpretation of experimental results in terms of mechanistic understanding, and the development of validation of kinetic models of fundamental processes. The project is divided into three major tasks, the details of which are provided. 20 figs., 1 tab.

24483 **(DOE/PC/71504—7) [Operation and maintenance of Pittsburgh Energy Technology Center, Combustion Test Facility, Pittsburgh, Pennsylvania]: Quarterly technical progress report, October 1, 1986 to December 31, 1986.** (Gilbert/Commonwealth, Inc., Reading, PA (USA)). 1986. Contract AC22-85PC71504. 107p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87008391.

Effective May 20, 1985, Gilbert/Commonwealth, Inc. (G/C) was awarded the contract to provide operational services for test facilities used for research and development in coal science and technology at the US Department of Energy's (DOE) Pittsburgh Energy Technology Center (PETC). The objective of this research and development is to expand the data base for: (1) combustion technology of coal, coal-slurry fuels and alternate fuels; (2) advanced environmental control technology to control emissions from combustion processes utilizing these fuels; and (3) other technology for utilization of coal in an environmentally acceptable manner. The contractual obligations of G/C are defined as follows: G/C shall furnish the necessary management, supervision, qualified personnel, operations, maintenance, modifications, materials, supplies, equipment, training, technical expertise, and services required to provide the Pittsburgh Energy Technology Center with the operational services for existing government-owned test facilities. G/C shall also provide technical and management services for additions to existing test facilities or perform major modifications to existing test facilities as directed in writing by the Contracting Officer. The overall conceptual design of all test facilities and their ultimate success are the responsibility of DOE/PETC. The operation of the test facilities at PETC can include any or all of the described processes, and progress in each in this reporting period is described.

24484 **(DOE/PC/80752—T7) Detailed model for practical pulverized coal furnaces and gasifiers: Quarterly technical progress report No. 7 for the period 1 November 1986 to 31 January 1987.** Smith, P.J.; Smoot, L.D. (Brigham Young Univ., Provo, UT (USA). Combustion Lab.). 28 Feb 1987. Contract FG22-85PC80752. 61p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006399.

This work is aimed at extending the comprehensive modeling research of the past ten years at the Combustion laboratory to practical industrial applications. Past efforts deliberately focused on development of a 2-dimensional, axi-symmetric model that provided for all of the physical and chemical effects that occurred in still more complex configurations while minimizing computer cost of development and evaluation. This 2-D code has been developed, evaluated through extensive comparison with measurements, and applied to selected problems. Extensive comparisons with measurements from coal gasification and combustion reactors have been encouraging, considering the complexity of these reaction processes. Based on the demonstrated utility of the 2-D work, the current contract is aimed at further improvement and extension of this technology to large-scale and three-dimensional pulverized coal furnaces and gasifiers. Not all of the physical and chemical issues are resolved and therefore, the thrust of this study is not only one of extending the code numerically to three-dimensions, but of conducting further work on subcomponents and of reviewing and incorporating on-going research by other investigators. Thus, the general objective of this study is to improve and extend the generalized two-dimensional, pulverized coal combustion and gasification code for application to large-scale, practical configurations, and to evaluate and implement the resulting code on an industrial scale. 29 refs., 22 figs., 3 tabs.

24485 **(DOE/PC/81520—T1) Development of optical fiber probe for solids holdup measurement in a fluidized bed: Final report for the period October 1, 1985-September 30, 1986.** Fan, Lin-Shih. (Ohio State Univ. Research Foundation, Columbus (USA)). Oct 1986. Contract AC22-85PC81520. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003180.

A method for measuring the local solids holdup in a fluidized bed has been developed using an optical fiber probe. The probe size, frequency response, and calibration methods were investigated. The developed probe system was applied to local solids holdup measurement in two-dimensional and three-dimensional fluidized beds. 4 refs., 9 figs.

24486 **(ECN—87-002) Effect of coke formation on combustion efficiency during recycling of FBC fly ash.** Vleeskens, J.M.; Roos, C.M.; Gerrits, B.J.; Van Haasteren, A.W. (Netherlands Energy Research Foundation, Petten). Dec 1986. 27p. (CONF-871030—1). ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

From Coal science international conference; Maastricht, Netherlands (26 Oct 1987).

Unburnt residues of fluidized combustion were shown to contain more coke than is consistent with the initial maceral composition of the parent coals. The composition of the cyclone-residue shifted further to higher coke-to-inertinite ratios as the recycle ratio increased, but remained constant over a wide range of air-to-fuel ratios. Chars from the cyclone were richer in coke than filter chars, in which inertinite residues tended to concentrate. The size of mosaic coke units was not influenced by either residence time or air-to-fuel ratio. The combined data suggest that the preferential combustion of inertinite compared to coke is the result of a lower resistance to wear under recycling conditions. No difference in reactivity was observed between coking and non-coking components. 8 figs., 1 tab., 9 refs.

24487 **(IEA/ICTIS/TR—34) Understanding pulverised coal combustion: IEA coal research.** Morrison, G.F. (International Energy Agency Coal Research, London (UK)). Dec 1986. 46p. NTIS (US Sales Only), PC A03/MF A01. File Number TI87900593.

This report reviews recent literature, mainly post 1980, on the fundamental processes and mechanisms of pulverised coal combustion. Three main sections cover devolatilisation, char oxidation and pollutant formation. The section on devolatilisation covers the physical behaviour of coal particles, the mass of volatiles emitted, volatile species, devolatilisation rates, combustion of volatiles and particle ignition. Char oxidation is reviewed in terms of char reactivity and parameters such as thermal dynamics of particles, surface area and porosity, coal structure, pyrolysis and mineral matter, which affect reactivity. Recent developments in our understanding of the formation of SO_2, NO/sub x/ and PAH are examined. It is concluded that whilst better understanding of the process of combustion may lead to the development of empirical models for specific sets of conditions, the sheer complexity of the process makes it unlikely that there can be a fundamental, universal model of coal combustion. Directions for further research are identified. 200 refs, 28 figs., 12 tabs.

24488 **(IEA/ICTIS/TR—35) Atmospheric fluidised bed boilers for industry.** Thomas, J.F.; Gregory, R.W.; Takayasu, M. (International Energy Agency Coal Research, London (UK)). Nov 1986. 67p. NTIS (US Sales Only), PC A04/MF A01. File Number TI87900638.

This study examines the current technical status of FBC boiler technology for industry. Included is a look at the extent of FBC boiler use, a discussion of when FBC is attractive to industry, an examination of the current status of major development problems or barriers and the expectations for ongoing R & D work. To thoroughly explore these subjects many FBC boiler plants were visited in Europe and North America and much communication was made with FBC users, manufacturers and designers. In addition the recent relevant literature was also reviewed.

24489 **(PB—87-140562/XAB) Alternative coal-combustion systems.** Martin, C.G.; Johnston, K.C. (Murray-North Partners Ltd., Auckland (New Zealand)). Aug 1986. 105p. NTIS, PC PC E05/MF E01.

The report reviews the state of the art of systems used for coal combustion, as applicable to the scale of New Zealand industry. Very large utility power station boiler plants are not considered. Combustion systems are classified by the arrangement used to bring the fuel and combustion air into contact, namely: fixed and moving grates with under, over and sideways feed of coal; fluid-bed reactors of the bubbling and fast types; entrained reactors using pulverized coal; and cyclone reactors. Each type of combustor is considered as part of the total combustion system consisting of reactor, fuel feeding and metering means, ash and clinker removal means, and means for control of atmospheric pollution by the exhaust gases. The heat user and heat transfer system are not considered other than directly in relation to their effect on combustion.

24490 **(TNO-HMT—85-071) A freeboard internal for coal-fired fluidized bed boilers.** Pohlmann, J.W. (Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands)). Jan 1985. 41p. (In Dutch). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751770.

The combustion efficiency of a coal-fired fluidized bed combustion boiler depends among other things on the residence time of the solid particles in the freeboard . TNO has developed a freeboard internal by which the residence time of the solid particles can be extended. The extension depends on the height of the internal, the particle size and the superficial gas velocity. In an internal with a height of 2 meter the mean residence time of 100 microm. particles increases with 0.9 seconds at a superficial gas velocity of 2.3 m/s. This results in an increase of at least 2% of the combustion efficiency of a fluidized bed combustion boiler without recycling. The internal has a positive influence on the mixing of the different gases and on the velocity distribution possibly too.

24491 **(TNO-HMT—86-057) Characteristics of coal/water mixtures. A desk-study.** De Jong, J.A. (Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands)). Apr 1986. 50p. (In Dutch). Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands.

Some aspects of the atomisation of coal water mixtures are reviewed in this report. Special attention was given to methods for the prediction of the quality of the atomisation process. The main reason for such is known from the experience that combustion quality strongly depends upon atomisation quality. The rheologic behaviour of coal water mixtures was poorly characterised until recent years. That is why at this moment viscosity is measured as a function of the shear rate in the range relevant for handling and atomisation of coal water mixtures. Methods for characterisation of the time-dependent behaviour of viscosity in and immediately after leaving the atomisation nozzle are not yet fully developed however. It is recommended to set up a method for the standardisation of the time-dependent behavior of viscosity of coal water mixtures. Such an investigation should include atomisation experiments at ambient conditions with additional combustion trials as a validation. This desk study was carried out under contract with the Management Office for Energy Research PEO within the framework of the National Coal Research Programme which is financed by the Ministry of Economic Affairs. 25 refs.

24492 **Slurry burner for mixture of carbonaceous material and water.** Nodd, D.G.; Walker, R.J. (to Dept. of Energy, Washington, DC). US Patent 4,644,878. 24 Feb 1987. Filed date 5 Nov 1985. vp.

A burner is described for atomizing and directing a carbonaceous material-water slurry into a combustion chamber comprising: a fuel delivery tube into which the carbonaceous material-water slurry is introduced and displaced therealong toward a first end thereof; an atomizing air tube coaxially positioned about the fuel delivery tube, the atomizing air tube coupled to an atomizing air source wherein the atomizing air source directs atomizing air under pressure into the atomizing air tube toward a first end thereof; a fixed generally cylindrical nozzle mounted to the combustion chamber and coupled to the respective first ends of the fuel delivery tube and the atomizing air tube. The nozzle has outer channels continuous with the atomizing air tube at the first end thereof through which the atomizing air is directed and an inner, aft center fuel channel is coupled to and continuous with the fuel delivery tube at the first end thereof. The nozzle further includes forward inner diverging fuel channels coupled to and continuous with the aft center fuel channel and forming relatively small acute angles therewith and through which the carbonaceous material-water slurry is directed toward the outer periphery of a forward end portion of the nozzle and exits therefrom.

24493 **The progress of char oxidation in fluidized bed combustion of a bituminous coal.** Walsh, P.M.; Dutta, A.; Beer, J.M. (The Energy Lab. and Dept. of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139). pp 664-676 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

Considering the relatively long residence times expected for coal particles in a fluidized bed, the carbon conversion in once-through operation of atmospheric pressure bubbling beds is surprisingly poor. One of the few experimental handles on this problem is provided by oxygen measurements along the height of the bed and freeboard. However, in interpreting gas composition data obtained by taking samples from the bed, allowance must be made for the correlation of gas composition with gas velocity, which causes the concentration-weighted sample composition to differ from the more useful flux-weighted mixed mean composition. A method has been developed for the interpretation of gas composition data and for modeling of gas-solid reactions in bubbling fluidized bed combustion. A key feature of this model is the assumption of uniform voidage throughout the bed, which was found to be a useful alternative to the bubble-emulsion flow division for large particle beds at high superficial velocity.

24494 **Combustion and emissions characteristics of processed coal residues in atmospheric fluidized bed combustors.** Rajan, S.; Taylor, E.W. (Mechanical Engineering and Energy Processes, Southern Illinois Univ., Carbondale, IL). pp 799-812 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

The overall economics of various coal conversion processes can be improved if the process residue can be further utilized to generate energy in boilers. In this paper, the feasibility of burning two process residues in an atmospheric fluidized bed combustor is investigated. The fuels tested are a beneficiation plant reject from a coal cleaning process to remove ash, and a partially devolatilized char produced as a by-product from a low BTU gasification process. Fluidized bed operating variables studied include bed temperature, fluidization velocity, fuel particle size and calcium/sulfur mole ratio. Results show that both the process residues can be burnt with reasonable success in the fuel tolerant fluidized bed combustor.

24495 **Fluidized bed industrial steam generation economics.** Gaglia, B.N.; Sebesta, J.J.; Sage, W.L.; Hall, A.W. (Stearns Catalytic Corp.). pp 814-831 of Proceedings of the 3rd annual Pittsburgh coal conference. Greensburg, PA; MEMS (1986). (CONF-860948—).

From 3. annual Pittsburgh coal conference; Pittsburgh, PA, USA (8 Sep 1986).

Atmospheric fluidized-bed combustion (AFBC) of coal for the generation of process steam is a viable option for industrial users. This combustion technology has made great advances in general acceptability in recent years. Numerous test and demonstration projects, including recent commercial units, have proven its technical merits. However, commercial acceptance of AFBC technology will ultimately depend on the overall economics of AFBC systems. This paper addresses the issues and options which affect the cost of owning and operating an industrial AFBC steam plant. The information presented in this paper is a result of work performed by Stearns Catalytic Corporation for the US Department of Energy. The object of this study is to investigate methods of improving the economics of industrial steam generation using fluidized bed combustion.

24496 **In situ Raman spectroscopy of high-temperature pyrite reactions related to deposit formation from coal.** Hamilton, J.C.; McCarty, K.F.; Nagelberg, A.S. (Combustion Research Facility, Sandia National Labs., Livermore, CA 94550). pp 251-258 of Fundamental aspects of high temperature corrosion - II. Volume 86-9. Shores, D.A.; Yurek, G.J. Pennington, NJ; The Electrochemical Society (1986). (CONF-860540—). Contract AC04-76DP00789.

From 169. meeting of the Electrochemical Society; Boston, MA, USA (4 May 1986).

Iron pyrite and marcasite (FeS/sub 2/) account for about half of the sulfur found in coal and are proposed as a major source of iron and sulfur in corrosive deposits formed in coal-burning systems. The authors have studied, in furnace and flame environments, high-temperature reactions of pyrite related to deposit formation. Oxidation and resulfidation of bulk pyrite were studied in a furnace using in situ Raman spectroscopy and thermogravimetric analysis. Deposit formation from pyrite-seeded flames on inert Pt/Rh substrates was studied using in situ Raman spectroscopy complemented by post-exposure analysis. Formation of the major deposit species, Fe/sub 2/O/sub 3/ and/or Fe/sub 1-x/S, depended strongly upon flame stoichiometry. Of particular importance for resultant corrosion, the addition of sodium (another common fuel impurity) in the form of sodium acetate mixed with pyrite caused sodium sulfate to appear in the deposits, apparently formed by in-flame reaction of the sodium acetate and the iron pyrite. Sodium sulfate, iron sulfide, and iron oxide form molten eutectics at operating temperatures and are candidate species likely responsible for hot corrosion in systems burning coal with pyrite inclusions.

24497 **Slurry burner for mixture of carbonaceous material and water.** Nodd, D.G.; Walker, R.J. (to Dept. of Energy). US Patent Application 6-795,294. 5 Nov 1985. 39p. Contract AC22-82PC51504. DE87007265 NTIS, PC A03/MF A01; GPO Dep. File Number DE87007265.

The present invention is intended to overcome the limitations of the prior art by providing a fuel burner particularly adapted for the combustion of carbonaceous material-water slurries which includes a stationary high pressure tip-emulsion atomizer which directs a uniform fuel into a shearing air flow as the carbonaceous material-water slurry is directed into a combustion chamber, inhibits the collection of unburned fuel upon and within the atomizer, reduces the slurry to a collection of fine particles upon discharge into the combustion chamber, and regulates the operating temperature of the burner as well as primary air flow about the burner and into the combustion chamber for improved combustion efficiency, no atomizer plugging and enhanced flame stability.

0150 Marketing And Economics

REFER ALSO TO CITATION(S) 24468, 24890, 24905, 24920

24498 **(DOE/EIA—0125(86/4Q)) Coal distribution, January-December 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). 30 Mar 1987. 187p. NTIS, PC A09/MF A01 - GPO; 1; GPO Dep. File Number DE87008310.

US coal distribution to domestic and foreign markets totaled 889.8 million short tons from January through December 1986. This was 1.1% more than the 880.5 million short tons distributed during the same period of 1985. For the second consecutive year, shipments exceeded production and purchases as producers and distributors reduced their stockpiles to meet an increased demand for coal by domestic users. Shipments within the US rose to 804.4 million short tons, 2% above the 788.5 million short tons distributed in 1985. By contrast, shipments to foreign markets decreased to 85.4 million short tons, 7.1% less than the 91.9 million short tons exported in 1985. Coal inventories at producers and distributors totaled 32.1 million short tons on December 31, 1986, compared with 33.1 million short tons on December 31, 1985. During January through December 1986: Total coal shipments and domestic shipments to electric utility plants were at a 5-year high level; shipments via tramway, conveyor, or slurry pipeline reached a 5-year high; coal produced or purchased was at the second highest level in 5 years; coal stocks on December 31 were at a 5-year low; and shipments via railroads were down for the second consecutive year. 6 figs., 33 tabs.

24499 **(LBL—22501) Assessment of negotiation options for coal-lease sales.** Rothkopf, M.H.; McGuire, C.B. (Lawrence Berkeley Lab., CA (USA)). Oct 1986. Contract AC03-76SF00098. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007892.

The Commission on Fair Market Value Policy for Federal Coal Leasing recommended that the government have authority to negotiate a fair price for coal leases when competitive bids cannot be obtained. This report analyzes the choices the government faces in designing a coal lease sale mechanism. It considers the impact of the alternatives on economic efficiency, government revenue, administrative workability, fairness and the appearance of fairness. The report concludes that there are advantageous ways for the government to negotiate coal leases when there is only one serious potential bidder for a lease. First, the report notes the advantages of negotiating exchanges that leave the government with economically logical potentially minable tracts. It also notes the advantages of negotiating shares for the "cooperative leasing" by auction of such tracts. For other one bidder tracts, the report concludes that there are potential advantages to ease negotiation provided that: (1) all negotiations are tentative subject to "validation" of their one bidder nature in a post-negotiation formal sale process, (2) the government negotiate on more leases than it will conclude, using whenever possible, a "round-robin" negotiation procedure, (3) government employees and not independent agents negotiate for the government, and (4) negotiations are narrowly confined to the amount of bonus. The report also suggests that the government may wish to consider use of final-offer arbitration on those leases, such as bypasses, on which both the government and the private party have high interest in reaching an agreement.

24500 **(NP—7770084) Technology of hard coal mining - an analysis with particular respect to industrial management.** Molnar, A. (Fribourg Univ. (Switzerland). Rechts-, Wirtschafts- und Sozialwissenschaftliche Fakultaet). 4 Jul 1985. 140p. (In German). NTIS (US Sales Only), PC A07. File Number DE87770084.

The technology of hard coal mining is dealt with discussing its industrial management. Making use of the Cobb-Douglas production function, the model designed for the measurement of technological progress is applied to the Saarberg mines. The monoproduct character of hard coal mining is providing ideal measurement conditions. Moreover, the publication evaluates the measured results of technological progress and compares them with the efficiencies of labour, capital and energy. It discusses the major effects of technological changes observed on the hard coal mining sector on the labour market and the environment.

0160 Health And Safety

REFER ALSO TO CITATION(S) 24452, 24474, 25989, 25994

24501 **(ESC-WR—86-22) Coal or nuclear power. Perception of energy risks.** Midden, C.J.; Daamen, D.D.; Verplanken, B. (Stichting Energieonderzoek Centrum Nederland, Petten. Energie Studie Centrum). Oct 1986. 15p. (In Dutch). Energie Studie Centrum ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

Some of the key findings are discussed of psychological research on the perception of risks and attitudes with respect to the use of uranium and coal for electricity generation. It appears that attitudes are mostly not based on ideology but rather determined by a trade-off of expected risks and advantages. Lay estimates of probabilities are compared with expert judgements. Attitudes of people living near existing or planned power plants are analyzed. Serious doubts are raised about the possibilities to give residents economic compensation for exposure to risks. 29 refs., 1 fig.

24502 **(PB—87-144093/XAB) Assessment of whole-body vibration levels of coal miners.** (Bolt, Beranek and Newman, Inc., Cambridge, MA (USA)). Jul 1983. 474p. NTIS, PC PC E99.

Set includes PB—87-144101 through PB—87-144127.

No abstract available.

24503 **(PB—87-144101/XAB) Assessment of whole body vibration levels of coal miners. Volume 1. Whole-body vibration exposure of surface-coal-mining machine operators. Open file report, November 1979-July 1984.** Remington, P.J.; Stahr, J.; Andersen, D. (Bolt, Beranek and Newman, Inc., Cambridge, MA (USA)). Jul 1983. 292p. (BBN—5332). NTIS, PC A13/MF A01.

See also Volume 2, PB—87-144119; Also available in set of 3 reports PC E99, PB—87-144093.

Field measurements utilizing a seat-pad accelerometer were made on 61 surface-coal-mining machines in order to quantify the vibration levels experienced by the operators. These data were combined with information on the statistics of the operating times of these machines in order to compare the operator's vibration exposure to the criteria of the International Standards Organization (ISO) Standard 2631, A Guide for the Evaluation of Human Exposure to Whole Body Vibration. The comparison showed that about one-half of all surface-coal-mining machine operators can be expected to be exposed to vibration exceeding the fatigue-decreased proficiency criterion, whereas only on the order of 15% would be expected to experience vibration exceeding the exposure limit. Detailed exposure statistics are presented and the implications of the results are discussed.

24504 **(PB—87-144119/XAB) Assessment of whole-body vibration levels of coal miners. Volume 2. Whole-body vibration exposure of underground coal mining machine operators. Open File report, November 1979-July 1084.** Remington, P.J.; Andersen, D.A.; Alakel, M.N. (Bolt, Beranek and Newman, Inc., Cambridge, MA (USA)). Mar 1984. 115p. (BBN—5616). NTIS, PC A06/MF A01.

See also Volume 1, PB—87-144101, and Volume 3, PB—87-144127; Also available in set of 3 reports PC E99, PB—87-144093.

Field measurements utilizing a seat-pad accelerometer were made on 25 underground-coal-mining machines in order to quantify the vibration levels experienced by the operators. These data were combined with information on the statistics of the operating times of these machines in order to compare the operator's vibration exposure to the criteria of the International Standards Organization (ISO) Standard 2631, A Guide for the Evaluation of Human Exposure to Whole Body Vibration. The comparison showed that about 30% to 40% of all underground-coal mining machine operators can be expected to be exposed to vibration exceeding the fatigue-decreased proficiency criterion, whereas only 10% to 15% would be expected to experience vibration exceeding the exposure limit. The primary sources of the exposure are shuttle cars and possibly scoop trams. Detailed exposure statistics are presented, and the implications of the results are discussed.

24505 **(PB—87-144127/XAB) Assessment of whole-body vibration levels of coal miners. Volume 3. Low-frequency vibration exposure and seat performance. Open File report, November 1979-April 1985.** Remington, P.J. (Bolt, Beranek and Newman, Inc., Cambridge, MA (USA)). Nov 1984. 67p. (BBN—5806). NTIS, PC A04/MF A01.

See also Volume 2, PB—87-144119; Also available in set of 3 reports PC E99, PB—87-144093.

The field data gathered as part of the measurements described in Volumes I and II were reanalyzed in the low frequency regime (.1 Hz to 1 Hz) where motion sickness normally occurs. These data were compared to the International Standard 2631 Addendum 2: Evaluation of exposure to whole-body Z-axis vertical vibration in the frequency range of 0.1 to 1.0 Hz. For both underground mining machines and surface-mining machines, the results showed that one would not expect motion sickness to be a severe problem. New field data were gathered on the vibration reduction performance of various seat designs found on surface-coal-mining machines. The vibration during normal operation was simultaneously measured on the seat using the standard seat-pad accelerometer packaged described in the previous two volumes, and on the floor of the machine at the base of the seat. Preliminary indications are that the so-called high performance seats used for operator vibration reduction do not offer significant improvement over conventional seats.

0170 Legislation And Regulations

REFER ALSO TO CITATION(S) 24499

02 PETROLEUM

0201 Reserves

REFER ALSO TO CITATION(S) 24523

24506 **West Virginia oil reservoirs--Reservoir data and enhanced oil recovery potential.** Watts, R.J. (U.S. Dept. of Energy, Morgantown Energy Technology Center, Morgantown, WV 26505). pp 39 of Proceedings of the fifteenth annual Appalachian petroleum geology symposium. Morgantown, WV; West Virginia Geological and Economic Survey (1984). (CONF-8403248—).

From 15. annual Appalachian petroleum geology symposium: old Appalachian oil fields; Morgantown, WV, USA (26 Mar 1984).

Reservoir geologic and engineering data for the major oil fields of West Virginia is summarized. Several of the reservoirs have been estimated to have contained over 50 million barrels of oil originally in place that may offer targets for the enhanced oil recovery processes.

0202 Geology And Exploration

REFER ALSO TO CITATION(S) 24506

24507 (CMI-R—852611-1) Selecting oil exploration strategies: some stochastic problem formulations and solution methods. Flaam, S.D.; Pinter, J. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Jul 1985. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751688.

This paper is concerned with the allocation of exploratory effort within the limitations imposed by a fixed budget. The budgetary constraints might reflect the capital markets' belief that providing additional funds for exploration would increase the risk of bankruptcy so much that a feasible interest would not give adequate compensation. By contrast, the expenditure limit on exploration may be self-imposed in order to preserve corporate control. In any case, managers are faced with a portfolio selection problem: how to allocate scarce capital resources to explore various risky prospects. A version of the stochastic decision problem is formulated, which differs from the standard formulation of the portfolio selection problem. According to the new formulation the objective is to maximize expected revenues, subject to a probabilistic constraint on the profitability of the portfolio and possible additional constraints. Different solution procedures are developed. 20 references.

24508 Comparison of methods for measuring kerogen pyrolysis rates and fitting kinetic parameters. Burnham, A.K.; Braun, R.L.; Gregg, H.R. (Lawrence Livermore National Lab., CA). pp vp of 193rd American Chemical Society national meeting. Washington, DC; American Chemical Society (1987). (CONF-870410—). Contract W-7405-ENG-48.

From 193. national meeting of the American Chemical Society; Denver, CO, USA (5 Apr 1987).

The authors determine rates of product evolution during pyrolysis of several petroleum source rocks and isolated kerogens by nonisothermal techniques, including Rock-Eval pyrolysis, condensed oil evolution, and on-line mass spectrometry. The resulting data are analyzed by nonlinear regression and simpler correlation techniques in terms of discrete and Gaussian distribution activation energy models. They find that temperatures measured by standard Rock-Eval analysis are too low by about 30°C, resulting in kinetic expressions that are much too fast. Proper temperature calibration eliminates this problem. They also assess how differences among kinetics for individual species relate to the activation energy distributions required for total hydrocarbon evolution. Finally, they explore the sensitivity of basin analysis to uncertainty in the kinetic parameters.

0203 Drilling And Production

REFER ALSO TO CITATION(S) 24599, 24919

24509 (CMI-R—852310-8) Production profiles for oil fields. Wallace, S.W.; Helgesen, C.; Nystad, A.N. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Sep 1985. 25p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751692.

A model for generating production profiles for an oil reservoir is presented. It is a tank-type model, and perfect communication throughout the reservoir is assumed. The physical model is a simple one, zero-dimensional in space, and both the case with water injection, and the case without, are treated. Based on a set of input data, the different cases that can occur, are described, as well as the typical production profiles in these cases. One reference.

24510 (CMI-R—852310-9) Optimal development of an oil field. Wallace, S.W.; Helgesen, C.; Nystad, A.N. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Sep 1985. 46p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751690.

It is shown how the optimal development of an oil field depends upon the size of the field and the well productivity. Initially, a homogenous field is assumed in which all wells have the same properties, and where the field is so small that only one platform is needed. Optimality is defined as the strategy that maximizes the expected net present value of the field. The most interesting effect that has been found, is that both the net present value of a field and the optimal technical solutions are very sensitive to the well-rates of the field. This is particularly so, if it can be taken into account before the platform is built. Additionally, if an increased well-rate comes as a surprise, the positive effect is substantial. Similarly, losses are small if low well-rates are known in advance of the main investment decisions, rather than if they come as a surprise, but in any case, the economic consequences are important. Oil price and discount rate are important for the net present value of a field, regardless of the field's commerciality, but given that the field is commercial, the effect of the oil price and discount rate on the optimal decision is small. 7 references.

24511 (CMI-R—862310-1) Treatment of stochasticity in field evaluations. Wallace, S.W.; Helgesen, C. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Apr 1986. 19p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751689.

The purpose of this work is to consider different ways of treating uncertainty in connection with the development of an oil field. It is assumed that the point of time is when the development decision is being made, and it is further assumed that the development concept has been chosen, i.e. the type and number of platforms. Only the resources are considered uncertain. There are of course other important uncertainties, such as price, wellrates etc. It is assumed that the goal of the decision makers is to maximize the expected net present value of the field, and that the decision concerning the production capacity of the platform has to be made on the basis of the available information. No more drilling will take place. It is shown that the maximal expected net present value and the corresponding optimal decision, depend on the degree of uncertainty facing the decision makers (the variance of the estimates). As a general rule it is concluded that for a given development concept the approximation of the expected net present value should be based on the median of the distribution, not the mean. Four references.

24512 (CMI-R—862330-1) On some operations research models for oil and gas field development. Hallefjord, Aa. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Feb 1986. 45p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751687.

Operations research techniques have been applied to oil and gas field development problems for some time. This selective survey paper gives a short presentation of some models and solution methods that have been proposed. Comments are made about the decisions that are modeled, and the level of detail that has been chosen. The models are of linear, nonlinear and integer programming type. They have been chosen so that they: (1) appear to be the most quoted in the area; (2) are based on decision problems that are relevant for oil field development, and/or are interesting from an algorithmic/computational point of view. 29 references.

24513 (DOE/BC—86/2) Contracts for field projects and supporting research on enhanced oil recovery. (USDOE Bartlesville Project Office, OK). Apr 1987. 112p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86000295.

Progress reports are presented for field tests and supporting research for the following: chemical flooding, gas displacement; thermal methods; resource assessment technology; environmental technology and microbial technology.

24514 (PB—87-143079/XAB) Potential of enhanced oil recovery by carbon dioxide flooding in New Mexico. Technical report, 30 August 1985-30 November 1986 (Final). Brashear, J.P.; Becker, A.B. (Interstate Oil Compact Commission, Oklahoma City, OK (USA)). Dec 1986. 177p. NTIS, PC A09/MF A01.

The report examines the potential of carbon dioxide miscible flooding in New Mexico to increase oil reserves and production, state and local revenues, state economic activity, jobs and wages, gross domestic product, and federal revenues. Using models and data bases built for the National Petroleum Council's study of enhanced oil recovery, 97 New Mexico reservoirs were evaluated to determine the potential of carbon dioxide flooding at prices from $16/barrel to $40/barrel; minimum rates of return of 10% and 15%; three tax treatments: current taxes and two incentive cases (relief from income and production taxes for the life of a project or until project payback). The results show that, at prices beginning at $20/barrel, substantial new reserves and production can be gained if tax incentives to payback are available, yielding substantial benefits to the state up to about $30/barrel. Beyond that price, incentives could be counter-productive to the state. Incentives can be administered through the use of a simple, readily measured ratio to determine approximately when payback occurs to minimize the administrative burden. With carefully designed incentives and oil prices in the $24-28/barrel range, New Mexico's oil production and oil-based taxes could be sustained at near current levels well into the next century.

24515 **Influence of geologic discontinuities on hydraulic fracture propagation.** Warpinski, N.R.; Teufel, L.W. (Sandia Natl. Labs.). *Journal of Petroleum Technology;* **39**: No. 2, 209-220(Feb 1987).

Geologic discontinuities, such as joints, faults, and bedding planes, can significantly affect the overall geometry of hydraulic fractures. This can occur by arresting the growth of the fracture, increasing fluid leakoff, hindering proppant transport, and enhancing the creation of multiple fractures. Results from mineback experiments and laboratory tests and analyses of these data are integrated to describe this complex fracture behavior.

24516 **Polymers for mobility control in CO/sub 2/ floods.** Dandge, D.K.; Heller, J.P. (New Mexico Petroleum Recovery Research Center). pp 297-306 of SPE international symposium on oilfield chemistry. Richardson, TX; Society of Petroleum Engineers (1987). (CONF-870244—).

From International symposium on oil field chemistry; San Antonio, TX, USA (4 Feb 1987).

The very low viscosity of the displacing fluid is the probable cause of much of the early breakthrough and poor areal sweep efficiency that plagues most applications of CO/sub 2/ flooding technology. A focussed and already partially successful research program is described, to develop polymers that are soluble in dense CO/sub 2/ and raise its viscosity sufficiently so that they can be used as direct thickeners for mobility control. Such water-free additives will offer greatly improved displacement efficiencies on both microscopic and macroscopic scales. Developed correlations between molecular structure and solubility in both simple hydrocarbon-CO/sub 2/ and in polymer-CO/sub 2/ systems are reviewed.

24517 **Polymerization in supercritical CO/sub 2/ to improve CO/sub 2//oil mobility ratios.** Terry, R.E.; Zaid, A.; Angelos, C.; Whitman, D.L. (Univ. of Wyoming). pp 289-296 of SPE international symposium on oilfield chemistry. Richardson, TX; Society of Petroleum Engineers (1987). (CONF-870244—).

From International symposium on oil field chemistry; San Antonio, TX, USA (4 Feb 1987).

In this paper a novel idea to increase the CO/sub 2/ viscosity is presented. The increasing of CO/sub 2/ viscosity is attempted by insitu polymerization of monomers miscible with CO/sub 2/. The polymerization is done while the monomer (solute) is in the CO/sub 2/ supercritical phase (solvent). CO/sub 2/ viscosity changes are evaluated by direct measurement using a high pressure Ruska rolling ball viscometer. Several runs have been made and polymerization has been successfully achieved - in the presence of CO/sub 2/ supercritical phase - as evidenced by NMR and infrared spectrophotometry. Both gas and liquid phase monomers, measured at standard conditions, were tried and both were polymerized.

24518 **Asphaltene flocculation during oil production and processing: A thermodynamic colloidal model.** Leontaritis, K.J.; Mansoori, G.A. (Univ. of Illinois at Chicago). pp 149-158 of SPE international symposium on oilfield chemistry. Richardson, TX; Society of Petroleum Engineers (1987). (CONF-870244—).

From International symposium on oil field chemistry; San Antonio, TX, USA (4 Feb 1987).

This paper presents a thermodynamic-colloidal model capable of predicting the onset of flocculation of colloidal asphaltenes in oil mixtures due to either changes in composition (i.e.: solvent addition) or electrical phenomena (i.e.: streaming potential generation due to flow of asphaltenes containing oil in conduits or porous media). For oil mixtures from which flocculation is caused simply by flow, the model can make predictions as to the velocity ranges where colloidal asphaltene flocculation can be avoided. This could have a significant impact on allowed reservoir drawdown rates, well spacing, and tubing design.

24519 **Cyclic gas/steam stimulation of heavy-oil wells.** Meldau, R.F.; Shipley, R.G.; Coats, K.H. (Husky Oil Operations Ltd.). pp 218-226 of Thermal recovery processes. Richardson, TX; Society of Petroleum Engineers (1985).

Cyclic steaming is a key tool to achieving economic production from reservoirs containing very viscous oil. Thus, there is an incentive for the development of better cyclic steaming techniques since heavy oil reservoirs in the U.S., Canada, and Venezuela contain a large amount of potential reserves. This paper briefly describes the Paris Valley thermal pilot and gives field results for cyclic steaming. Computer model results help explain the improved performance noted when gas is added to the steam.

24520 **Offshore installations guidance on design and construction. 3rd edition (1984).** Norwich, England; HMSO Books (1984). 153p. HMSO Books, Publications Div., Room 2C03 St. Crispins, Duke St., Norwich, England NR3 1PD.

This book explains the procedure whereby fixed and mobile offshore installations are certified as being fit for their purpose in accordance with the Offshore Installations (Construction and Survey) Regulations 1974.

24521 **Results of the Department of Energy's field activities in enhanced oil recovery in the Appalachian Basin.** Yost, A.B. II. (U.S. Dept. of Energy, Morgantown Energy Technology Center, Morgantown, WV 26505). pp 44 of Proceedings of the fifteenth annual Appalachian petroleum geology symposium. Morgantown, WV; West Virginia Geological and Economic Survey (1984). (CONF-8403248—).

From 15. annual Appalachian petroleum geology symposium: old Appalachian oil fields; Morgantown, WV, USA (26 Mar 1984).

Results of the West Virginia projects show that additional oil can be technically recovered from waterflooded low oil saturation reservoirs using carbon dioxide miscible displacement flood processes. However, reservoir sweep efficiencies are low due to poor process mobility ratios. Technical success of the micellar/polymer project was limited because of poor reservoir characteristics for the process.

0204 Processing

REFER ALSO TO CITATION(S) 24409, 24412, 24518, 25132, 25169

0205 Products And By-products

24522 **(ERATL—87/01/XAB) Investigations into the performance of structures acting as inadvertent receivers of electromagnetic energy in the context of the r-f ignition hazard. Final report.** Maddocks, A.J. (ERA Technology Ltd., Leatherhead (UK)). 1983. 108p. (ERA—83-0096). NTISPC $139.00.

The process whereby metallic structures situated on gas and petrochemical processing plants can have power induced from radio transmissions is investigated together with the possibility that there could be sufficient power available to cause ignition of flammable gases or vapors surrounding the structure. The structures were simulated by small uniform loops constructed from steel tube and were irradiated from a controlled remote radio-transmission source. The induced voltages and available powers on the simulated loops were compared with the results obtained on real plant structures, and sets of generalized curves were derived that may be useful in the prediction of potential r-f ignition hazards. The frequency range covered by the work is 200kHz to 30MHz. Remedial measures and methods whereby an empirical on-site assessment can be made are discussed. The work was carried out so as to provide additional information relevant to the revision of BS 4992 Guide to Protection Against Ignition and Detonation Initiated by Radio-Frequency radiation.

0206 Health And Safety

REFER ALSO TO CITATION(S) 24522, 25994

0207 Marketing And Economics

REFER ALSO TO CITATION(S) 24510, 24890, 24905, 24910, 24911, 24912, 24913, 24914, 24915, 24916, 24919

24523 **(CMI-R—852330-3) Choice of production capacity to deplete a petroleum deposit: the case of uncertain reserves and well productivity.** Flaam, S.D. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Feb 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751691.

It is explored how uncertainty about reserves and well productivity affects the optimal production capacity of a petroleum deposit. It is found that even under risk-neutrality one should respond to greater uncertainty in the reserves by installing less capacity. This conclusion depends on the interest rate not being very small and the reserves not being depleted very quickly. Four references.

24524 **(CMI-R—852330-4) On the choice of production regularity when depleting a petroleum deposit.** Flaam, S.D. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Feb 1985. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751703.

The paper is concerned with the choice of production regularity when some resource deposit is depleted over an extended time span. It is also explored how increased uncertainty about available reserves affects the optimal choice of regularity. Efficient recursion formulae for calculating the gross revenue associated with a specified regularity, are obtained. These formulae make it unnecessary to resort to simulations. In fact, in a simplified binomial model, the resulting expression is given in closed form. This expression is then applied to show how uncertainty about available reserves may affect the chosen level of regularity. The response to greater uncertainty depends on the parameters of the problem, i.e. the discount factor, the probability distribution and the level of regularity. It is found for realistic parameter values that greater uncertainty causes the optimal regularity to be reduced. 3 drawings.

24525 **(DOE/EIA—0109(87/01)) Petroleum Supply Monthly, January 1987.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). 24 Mar 1987. 100p. NTIS, PC A05/MF A01 - GPO; 1; GPO Dep. File Number DE87007653.

Summary statistics are tabulated. (PSB)

24526 **(DOE/EIA—0504) Industrial fuel switching.** (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). 19 Feb 1987. 95p. NTIS, PC A05 - GPO. File Number DE87007957.

An analysis of both actual fuel substitution in 1984 and potential fuel substitution in the manufacturing sector is presented. This analysis is based on the 1984 Dun & Bradstreet Major Industrial Plant Database (MIPD). This is a proprietary data base containing detailed energy use information for the 20,000 largest energy consuming manufacturing plants. In addition, this report provides a summary of the MIPD at both the national and Census region level and compares the Dun and Bradstreet data to other available data sources. This information is distributed as an EIA information service to the executive branch, Congress, state and local governments, private industry, and the general public.

24527 **(DOE/FE—0080) Naval petroleum and oil shale reserves: Annual report of operations, Fiscal Year 1986.** (USDOE Assistant Secretary for Fossil Energy, Washington, DC. Office of Naval Petroleum and Oil Shale Reserves). 1987. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007726.

Market prices for curde oil experienced their greatest decline in history during 1986, with substantial effect on the Naval Petroleum and Oil Shale Reserves. Sales procedures which had served the Department well in prior years during periods when oil prices were stable or rising were found inadequate to cope with these declines, and new sales procedures were developed and implemented. Congressional concern that the Government receive fair prices from Naval Petroleum Reserves (NPR) petroleum sales also led to Public Law No. 99-413, enacted on August 29, 1986, which amended title 10, United States Code, Chapter 641. This law sets a minimum price, using two criteria, under which petroleum from the NPR cannot be sold. Notwithstanding the decline in oil and gas prices, revenues from the sale of NPR petroleum totaled $763 million in 1986. Although this represented a 41% decline from 1985 receipts, the 1986 revenues well exceeded net program expenditures of $157 million. Because of the decline in prevailing oil prices during the second quarter of 1986, major cost reductions of $3.4 million were implemented at NPR-3, and even greater reductions are planned for 1987 to ensure the profitability of that field. The decline in energy prices also affected plans to protect natural gas underlying Naval Oil Shale Reserve No. 3 (NOSR-3). Two of 14 planned wells were drilled and are available for production. Unfortunately, efforts to sell gas from these wells have been unsuccessful, and further drilling has been delayed until the gas market is stronger. 16 figs., 20 tabs.

24528 **(DOE/PE/77035—T1) The International Energy Agency's mandatory oil sharing agreement: Tests of efficiency, equity, and practicality: [Final report].** Horwich, G.; Jenkins-Smith, H.; Weimer, D.L. (Purdue Univ., Lafayette, IN (USA); New Mexico Univ., Albuquerque (USA); Rochester Univ., NY (USA)). [1986]. Contract FG01-85PE77035. 45p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006072.

The International Energy Program Agreement, which created the International Energy Agency (IEA) in November 1974, establishes a system for the mandatory sharing of petroleum during severe oil supply disruptions. Development of the agreement was initiated by then Secretary of State Henry Kissinger during the attempted embargo of oil shipments to the US and The Netherlands by the Organization of Arab Petroleum Exporting Countries in 1973. Kissinger feared that the scramble for oil supplies would strain the Western alliance and contribute to a Western European "tilt" toward the Arab position in the Mideast. A new framework for international cooperation in the sharing of oil during oil embargoes and other supply disruptions seemed desirable; ensuring everyone their "fair share" would help blunt the oil weapon. Twenty-one countries, including the United States, Japan, and all the countries of Western Europe except France, affirmed this view through their membership in the IEA. The mechanism intended to achieve "fair" distribution of petroleum during severe disruptions is the Emergency Sharing System (ESS). Our evaluation of the ESS attempts to answer three questions: First, what would be the economic consequences for the US and other IEA members if sharing were to be implemented? Second, how do limitations in information and market control hinder implementation? Third, in light of such impediments, what are likely to be the actual economic consequences of attempted implementation?

24529 **(DOE-tr—7007877) Efficiency of measures for reducing consumption in the event of disruptions in the supply of petroleum and crude oil.** Wittke, F.; Hopf, R. (Deutsches Inst. fuer Wirtschaftsforschung, Berlin (Germany, F.R.)). Nov 1986. Translation source information not available . 248p. NTIS, PC A11. File Number DE87007877.

The extent to which the measures prepared by the federal government are suitable now and in the future are reviewed, given the changed situation in the oil market since 1979/80, to reduce considerably the consumption of combustible and diesel fuels as well as of light heating oils in a crisis situation. This study is to be based on selected measures for bridging bottlenecks in the supply of the Federal Republic of Germany with petroleum and crude oil products. Specifically, the following measures are the subject of the present study: public appeal to save energy in the Federal Republic in the event of crude oil supply disruptions; recommendation to the crude oil industries to limit the delivery of light heating oil and to limit the gas station hours of operation as well as the request to discontinue the practice of filling spare fuel canisters; legal decree to reduce the speed limit (highway: 100 km/h; rural roads: 80 km/h); legal measures concerning a prohibition against driving on weekends: absolute prohibition, and on alternating weekends; legal measures to prohibit sporting events using motorized vehicles and for prohibiting traffic in leisure aircraft and boats; decree concerning delivery limitations for fuel in the event of a supply crisis per April 26, 1982; General Administrative Decree for the Fuel-Limited-Delivery Act of April 27, 1982; and decree concerning limitations on the delivery of light heating oil in the event of a supply crisis per April 26, 1982; General Administrative Decree for Heating Oil Delivery Limitation Act of April 27, 1982.

0208 Waste Management

REFER ALSO TO CITATION(S) 24555

0209 Environmental Aspects

24530 **(EGG—10282-2144) Reproduction of the San Joaquin kit fox on Naval Petroleum Reserve No. 1, Elk Hills, California: 1980-1985.** Zoellick, B.W.; O'Farrell, T.P.; McCue, P.M.; Harris, C.E.; Kato, T.T. (EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations). Jan 1987. Contract AC08-83NV10282. 51p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007865.

Reproduction of the San Joaquin kit fox (Vulpes macrotis mutica) was studied in areas of petroleum development and areas relatively undisturbed by development on and adjacent to Elk Hills Naval Petroleum Reserve No. 1 (NPR-1), California from 1980-1985. Pregnancy rates of adults did not differ between habitats (93 to 100%), but the yearling pregnancy rate in developed habitat (56%) was lower than the adult rates and the yearling rate for undeveloped habitat (100%). Mean corpora lutea and placental scar counts did not differ between undeveloped and developed habitats, but adults had greater corpora lutea and placental scar counts than yearlings. Litter sizes averaged 4.1 and 4.4 for undeveloped and developed habitats respectively from 1980-1985 and did not differ between years or habitats. Mean number of litters observed per square mile during 1980-1985 did not differ between undeveloped (0.34) and developed habitats (0.29). The percentage of all females successfully raising pups in developed habitat declined significantly from 1980-1985 in comparison with the percent success of females in undeveloped habitat. Numbers of litters per square mile in developed habitat also declined significantly after 1981. The sex ratio of pups trapped in developed habitat was skewed towards males during the decline in litters produced per square mile from 1982-1985, but the ratio of males to females in undeveloped habitat did not differ from 1:1 during this time. The decline in some measures of reproductive success in developed habitat after 1981 coincided with a decrease in black-tailed jackrabbit and desert cottontail numbers on the NPR-1 study area. The decreased reproductive success of foxes in developed habitat after 1981 may have resulted from habitat degradation caused by oil field production activities, declining lagomorph numbers, or other unknown causes. 49 refs., 7 figs., 8 tabs.

24531 **(PB—87-143004/XAB) Oil spills, 1976-85: statistical report.** Cotton, U. (Minerals Management Service, Reston, VA (USA)). 1986. 41p. (OCS/MMS—86/0085). NTIS, PC A03/MF A01.

Oil spillage resulting from drilling and production activities on the Outer Continental Shelf (OCS) is a matter of wide public concern. This report provides a complete and accurate statistical account of all the oil spills reported relative to oil and gas operations on the OCS. The report is prepared especially with those in mind who are concerned with accident prevention utilizing the various kinds of analyses and preaccident investigation techniques. Data are presented in tables and figures showing relationships between number of spills, volume of spills, accident years, cause of spills, location of spills, type of operations, and amount of production. The statistics in the tables and graphs are derived primarily from the OCS Events File. They summarize the spills that MMS has recorded. The statistics are not an evaluation of the systems that allowed the accidents to occur.

24532 **(PB—87-144143/XAB) Oil-spill risk analysis for the central and western Gulf of Mexico (Proposed Sales 110 and 112) Puter Continental Shelf lease areas.** Hannon, L.J.; Anderson, C.M.; LaBelle, R.P.; Lucas, A.D. (Minerals Management Service, Reston, VA (USA)). Jun 1986. 73p. (OCS/MMS—86/0116). NTIS, PC A04/MF A01.

See also report dated Apr 85, PB—86-148376.

The Federal Government has proposed to offer Outer Continental Shelf (OCS) lands off the Central and Western Gulf of Mexico coasts for oil and gas leasing. The report examines what could happen if oil is found, and attempts to compare relative risks of future leasing with risks of existing leases and transportation of imported oil in the study area. This report summarizes results of an oil-spill risk analysis conducted for the proposed OCS lease offerings in the Central and Western Gulf of Mexico (Sales 110 and 112).

24533 **(PB—87-144713/XAB) Measured data on NOx emissions in European refineries.** (Concawe, The Hague (Netherlands)). 1986. 12p. (CONCAWE—6/86). NTIS, PC PC E03/MF E01.

Recent NOx concentration measurements provided by CONCAWE member companies, confirm earlier estimates of oil-refinery NOx emissions. For 1985, emissions from refineries are calculated to contribute 1.4% and 1.2% of total man-made NO emissions in OECD Europe and EEC-10 respectively. (Copyright (c) Concawe Den Haag October 1986.)

24534 **(STF—21A85015) Shore cleaning and treatment of oil containing waste.** Halmoe, G.; Danielsen, A.; Denstad, J.; Klokk, T.; Sendstad, E.; Sveum, P. (SINTEF, Trondheim (Norway)). 24 Jan 1985. 38p. (In Norwegian). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751694.

The various processes of cleaning shores of oil spills are studied - both natural and various measures man can use to facilitate the processes. Biodegradation may be aided by fertilizer. The biological damage the oil may do to the shores depend on the type of oil, amount and how long it stays, season, the composition of the biological community and the selfcleaning ability of the shores. Plant life will be more disturbed in the growth season than in winter while beach invertebrates are influenced the most during winter due to reduced freezing tolerance induced by oil spills. Biological damage due to cleaning method seem to depend more on what season it is carried out in than the actual method. Methods particularily suitable for the Norwegian rocky shores are mentioned as well as destruction of gathered oil by burning and composting. The various development and improvement paths for existing methods are mentioned. 2 drawings.

24535 **(STF—21A85023) Consequence analysis oil/sea birds for Moere I and Troms II. General part: Oil spreading and decomposition and damage to seabirds.** Sandvik, J. (SINTEF, Trondheim (Norway)). 31 Jan 1985. 25p. (In Norwegian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751700.

The report gives a general account of what may be expected to happen to oil from an uncontrolled blowout at sea. The effects of oil on sea birds, both external and internal damages, are described. In what situations and what species of sea birds are most vulnerable are discussed. Some damage reducing measures are commented on. 2 tables, 8 drawings, 27 references.

24536 **(STF—21A85062) Depositing oil containing seaweed in biologically active deposits.** Sveum, P. (SINTEF, Trondheim (Norway)). Jun 1985. 12p. (In Norwegian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751695.

Biological active deposits of oil containing seaweed was made after the Deifovos was wrecked in spring 1981. The deposits were anaerobic in the beginning, later aerobic. After three years all the alkanes had disappeared. No oil uptake is registered in the grass, Festuca rubra, cultivated in oil contaminated seaweed material. 2 tables, 1 drawing.

24537 **Recommended methods for testing the fate and effects of dispersed oil in marine sediments.** Anderson, J.W.; Vanderhorst, J.R.; Kiesser, S.L.; Fleischmann, M.L.; Fellingham, G.W. (Battelle, Pacific Northwest Labs., Marine Research Lab., 439 West Sequim Bay Road, Sequim, WA 98382). pp 224-238 of Oil spill chemical dispersants: Research, experience and recommendations. Philadelphia, PA; ASTM (1982). (CONF-8210349—).

From ASTM Committee F-20 symposium on hazardous substances and oil spill response; West Palm Beach, FL, USA (12 Oct 1982).

Tests have been conducted to determine the extent of dispersed oil sorption on sediments and retention of this association when seawater is flushed through the substrate. Sediment beds were prepared where dispersed oil in seawater was allowed to percolate down through the sand. Water concentrations of dispersed oil were determined before and after percolation. Distribution of oil in sediments was shown to be very patchy and not suitable for quantitating effects on benthic species. Eighty-three percent of the oil remained in the top 3 cm during this process. Additional tests in special cores showed that sediments containing dispersed oil would release about 40% of the oil when seawater flowed from the bottom of the core up through the bed of sand.

24538 **Toxicity testing with constant or decreasing concentrations of chemically dispersed oil.** Kiesser, S.L.; Mc Querry, D.L.; Riley, R.G.; Fleischmann, M.L. (Research Lab. of Battelle, Pacific Northwest Labs., 439 West Sequim Bay Road, Sequim, WA 98382). pp 14-22 of Oil spill chemical dispersants: Research, experience and recommendations. Allen, T.E. Philadelphia, PA; ASTM (1982). (CONF-8210349—).

From ASTM Committee F-20 symposium on hazardous substances and oil spill response; West Palm Beach, FL, USA (12 Oct 1982).

An exposure system and method of quantitating toxicity have been developed to provide an estimate of the effects of dispersed oil on marine organisms under a variety of exposure conditions. Results of constant concentration exposures (for hours or days) can by compared to those of diluting exposures (decreasing to zero in 8 or 24 h) on a basis of the "toxicity index." This index is equal to the total exposure when time in hours or days is multiplied by the concentration at each hour (ppm . h or ppm . days). Tests have been conducted with shrimp (Pandalus danae), two oils (Prudhoe Bay crude and a light Arabian crude), and two dispersants. There is a seasonal pattern to the tolerance of the shrimp. Tests in the colder months (fall/winter) produce toxicity indices approximately three times higher than summer/spring values.

0220 Transport, Pipelines, And Handling

REFER ALSO TO CITATION(S) 24478

24539 (NP—7751733, pp 1-26) **Heating fuel oil.** Strunk, G. 1982. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751733.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.3. Energy distribution.

In the framework of comparative evaluations regarding the use of alternative energy sources in the Rhine and Neckar region, the distribution cost of heating oil, as the energy source to be replaced by alternative ones, is to be established. EL heating oil is purchased by the dealers from three refining points at Mannheim, Speyer, and Karlsruhe. In 1980 households and small consumers in the region mentioned were supplied with about 1 million tons of EL heating oil. More in detail presented are the calculations for storage and turnover cost, cost of export, sales and administration cost and cost from the calculation point of view. The publication gives the most important factors of influence for these individual cost groups and indicates how these are accounted for in the cost calculation formulas. Furthermore the distribution costs for the different settlement types were calculated. Finally hints are given as to fuel demand, which depends very much on constructional factors (size of the oil tank, thermal insulation measures). (HWJ).

0230 Properties

REFER ALSO TO CITATION(S) 24412, 24437, 24518

24540 **(LBL—21330) Molecular characterization of nickel and vanadium nonporphyrin compounds found in heavy crude petroleums and bitumens.** Fish, R.H.; Reynolds, J.G.; Gallegos, E.J. (Lawrence Berkeley Lab., CA (USA); Chevron Research Co., Richmond, CA (USA)). Nov 1986. Contract AC03-76SF00098. 22p. (CONF-860425—41). NTIS, PC A02. File Number DE87007179.

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

Pyridine/water extracts of selected crude petroleums were separated by polarity on a high performance liquid chromatography (HPLC) octadecylsilane column (ODS) into three fractions; low, moderate, and high polar. The moderate and low polar fractions were examined by electron impact mass spectroscopy (EIMS) to elucidate structural and behavioral characteristics of vanadyl petroporphyrin and metallo-nonporphyrin compounds. The EIMS results indicated vanadyl petroporphyrins in Cerro Negro and Wilmington moderate polar fractions and possibly in the Wilmington low polar fraction. These EIMS results showed the presence of petroporphyrins in the above-mentioned fractions, but no discrete information about the metallo-nonporphyrins. A highly polar nickel fraction from a Wilmington crude petroleum pyridine/water extract, separated on the ODS column, was further purified on a cyano normal phase column. This fraction had a nickel concentration of approximately 15,000 wppM, and was examined by EIMS mass spectroscopy. The spectral results indicated several homologous series structures possible for the binding sites of nickel. Further examination of the same fraction by positive ion fast atom bombardment mass spectroscopy, using a metal ion exchange technique, showed a substantially simplified spectrum and indicated the possibility of the nickel binding sites being small molecular weight naphthenic (carboxylic) acid salts. Gilsonite, a bitumen, was analyzed by reversed-phase HPLC with graphite furnace atomic absorption element specific detection, which indicated that the nickel is predominantly bound as metallopetroporphyrin, while a small portion eluted as a highly polar metallo-nonporphyrin fraction. These results are important in the identification of nonporphyrin metal-containing compounds in heavy crude petroleums and residua and could be beneficial for future petroleum exploration as metallobiomarkers. 21 refs., 11 figs.

0250 Combustion

24541 (CONF-8604156—, pp 29-37) **Catalytic radiant tube for industrial process heating applications.** Lannutti, J.L.; Schreiber, R.J.; Lukasiewicz, M.A. (Alzeta Corp., Santa Clara, CA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

This paper describes research on an innovative industrial process heating concept using catalytic radiant tubes. The gas-fired radiant tube concept employs a combustion catalyst applied to the inside surface of a ceramic tube. A preheated, combustible mixture of gas and air passing through the tube burns catalytically on the tube surface. Some of the heat generated conducts through the wall and is transmitted by radiation from the outside surface to the heat sink. Advantages over existing gas-fired radiant tubes include more uniform tube heating and low NO/sub x/ emissions. During this project, silicon carbide tubes were catalyzed with platinum and metal oxide catalysts and operated in a laboratory combustion test apparatus. The results were encouraging. A tube temperature of 1100°C was achieved, and heat flux (47.3 to 94.6 kW/m^2) was comparable to that of electric elements. NO/sub x/ concentration was negligible. The tube material did not experience thermal shock. Catalyst stability was the limiting factor. Future work will concentrate on developing a better catalyst and catalyst coating method which will then lead to stable combustion operation. Following the identification of a reliable catalyst, a prototype furnace using the radiant catalytic tubes will be built and tested. When commercialized, this concept could be used in place of the currently popular electric resistance elements. 11 references, 10 figures.

03 NATURAL GAS

0302 Geology And Exploration

24542 **(DOE/MC/21181—1950-Vol.7) Geological evolution and analysis of confirmed or suspected gas hydrate localities: Volume 7, Basin analysis, formation and stability of gas hydrates in the Colombia Basin.** Finley, P.; Krason, J. (Geoexplorers International, Inc., Denver, CO (USA); USDOE Morgantown Energy Technology Center, WV). Mar 1986. Contract AC21-84MC21181. 194p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86006637.

This report presents a geological description of the Columbia Basin, including regional and local structural settings, geomorphology, geological history, stratigraphy, and physical properties. It provides the necessary regional and geological background for more in-depth research of the area. Detailed discussion of bottom simulating acoustic reflectors, sediment acoustic properties, distribution of hydrates within the sediments, and the relation of hydrate distribution to other features such as salt diapirism are also included. The formation and stabilization of gas hydrates in sediments are considered in terms of phase relations, nucleation, and crystallization constraints, gas solubility, pore fluid chemistry, inorganic diagenesis, and sediment organic content. Together with a depositional analysis of the area, this report is a better understanding of the thermal evolution of the locality. It should lead to an assessment of the potential for both biogenic and thermogenic hydrocarbon generation. 66 refs., 49 figs., 5 tabs.

24543 **(DOE/METC—87/0249) Morgantown Energy Technology Center technology status report: Western gas sands.** (USDOE Morgantown Energy Technology Center, WV). Jan 1987. 23p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001030.

Western gas sands research is conducted by the US Department of Energy's (DOE) Morgantown Energy Technology Center to encourage the development of very low-permeability lenticular gas sands in the western US. This research is an integral part of DOE's Unconventional Gas Recovery Program, which is a multidisciplinary effort to develop the technology for producing natural gas from resources that have been classified as unconventional because of unique geologies and production mechanisms. The purpose of this research is to demonstrate to private industry the feasibility of economically producing natural gas from these low-permeability reservoirs. The reservoirs, which are found within a resource area that covers 311,000 square miles, contain an estimated 466 trillion cubic feet (tcf) of gas-in-place. Two broad research goals have been defined: (1) to reduce the uncertainty of the reservoir production potential, and (2) to improve the extraction technology. These goals are being pursued by conducting research and encouraging industrial efforts to develop the necessary technology. The focus of the research for the last several years has been on improving diagnostic instrumentation for reservoir and stimulation performance evaluation, geophysical and engineering interpretation, and stimulation techniques. Integrated geologic studies of three depositional basins that contain tight lenticular sandstone units have also been pursued as part of this new effort. These lenticular sands were selected by DOE as priority research targets because of the size of the resource potential and the many technical and economic questions blocking industry development. 9 refs., 10 figs., 3 tabs.

24544 **(DOE/METC—87/0250) Deep source gas: Technology status report.** (USDOE Morgantown Energy Technology Center, WV). Jan 1987. 23p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001031.

Deep Source Gas research is focused on the hypothesis that natural gas is generated in sediments carried to great depths at convergent plate boundaries in the Earth's crust. These deeply emplaced sediments may be the source of gas for shallower, drillable traps. Many areas of North America are believed to have experienced plate tectonic convergence. The western Cordilleran Geologic Province, in particular, appears to have geologic fault structures (associated with subduction and obduction) that enabled deep emplacement of hydrocarbon-generating sediments during more recent geologic ages (during the last 180 million years). The specific area of interest in this Province encompasses approximately 1.5 million square miles of the western US (including Alaska) and Canada; other portions of this same province extend southward into Mexico and Central and South America. The ongoing research consists of basic studies of hydrocarbon generation, stability, and preservation of depths in excess of 30,000 feet, in addition to a comprehensive evaluation of the geologic structures, stratigraphy, and geochemistry of the above region. Results to date include (1) geologic and geophysical evidence of deeply emplaced sedimentary rock units at depths exceeding 30,000 feet in western Washington and south-central Alaska, (2) a new methodology for verifying deep methane stability with fluid inclusion studies, and (3) a preliminary gas resource estimate of 3000 Tcf. 17 refs., 7 figs., 3 tabs.

24545 **Crosswell acoustic surveying of gas sands travel-time pattern recognition, seismic Q, and channel waves.** Albright, J.N.; Johnson, P.A. (Los Alamos National Lab., Los Alamos, NM). pp 1-19 of Transactions of the SPWLA 26th annual logging symposium. Houston, TX; Society of Professional Well Log Analysts Inc. (1985). (CONF-8506104—).

From 26. Society of Professional Well Log Analysts annual logging symposium; Dallas, TX, USA (17 Jun 1985).

The application of crosswell acoustic measurements to gas sands research has been explored through surveys conducted in the Mesa Verde formation at the Department of Energy Multi-Well Experiment (MWX) site near Rifle, Colorado. The borehole tools used in the survey are similar in concept to those used in commercial service for sonic logging, but they are especially adapted for the stringent requirements of crosswell shooting in hot gas wells.

0303 Drilling, Production, And Processing

REFER ALSO TO CITATION(S) 24512, 24520

24546 **(DOE/IG—0235) Audit of wet gas processing at Chevron's McKittrick Plant, Naval Petroleum Reserve No. 1, Elk Hills, California.** (USDOE Office of Inspector General, Washington, DC). 10 Apr 1987. 23p. OSTI, PO Bx 62, Oak Ridge, TN 37831. File Number TI87007820.

The purpose of the audit was to determine if: (1) volumes of wet gas delivered to the McKittrick plant were properly calculated and reported; (2) processing fees paid to Chevron conformed to contract provisions; (3) wet gas processing at Chevron's facility was economical; and (4) controls over natural gas liquid sales were adequate. Our review showed that there were weaknesses in internal controls, practices and procedures regarding the Department's management of the wet gas which is processed by Chevron under contract to the Reserve. The findings, recommendations and management comments are synopsized in the Executive Summary.

0306 Marketing And Economics

REFER ALSO TO CITATION(S) 24478, 24526, 24527, 24890, 24905, 24921, 25164

24547 (CONF-8604156—, pp 7-12) **Burning issues for industries using natural gas.** Rosenberg, R.B. (Gas Research Institute, Chicago, IL). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Industrial users of natural gas have three major considerations when evaluating process upgrading or new facilities investments. These are: (1) future availability of natural gas, (2) the cost of these supplies of gas, and (3) the capabilities of natural gas equipment to meet product and productivity needs. GRI conducts an R & D program on behalf of the utility gas industry that is oriented toward helping to ensure that adequate supplies of economically priced gas are available for the foreseeable future and that end-use equipment is available to provide energy services at the least cost to the consumer. GRI's analytical studies indicate that gas supplies are adequate to meet projected needs until after the turn of the century and that advanced technology will extend these supplies well into the 21st century. GRI's end-use R & D is developing new and improved industrial processes for gas to meet industry's increasing more stringent cost, product quality and productivity demands. 7 figures, 1 table.

24548 (CONF-8604156—, pp 13-22) **Combustion problems in the steel industry.** Wilde, J.D. (North American Manufacturing Co., Cleveland, OH). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Natural gas usage in the steel industry is discussed with emphasis on the modernization of the industry and new equipment. Ladle heating, soaking pits, reheat furnaces and batch-type furnaces are discussed.

24549 (CONF-8604156—, pp 23-25) **Combustion progress, problems, needs in the glass industry.** Drake, R.A. (Glass Technical Institute, Vienna, VA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Natural gas usage in the glass industry is discussed. The article is divided into three sections. The first gives a brief historical account of progress in the field. The last two sections address the problems of the industry and its combustion needs.

24550 **(PB—87-149365/XAB) Component cost assessment for main extensions and new residential service hookups. Final report, May 1984-January 1985.** Joyce, T.J.; Biederman, N. (Joyce (T.) Associates, Inc., Fairfax, VA (USA)). Oct 1986. 165p. NTIS, PC A08/MF A01.

The principal cost components for attaching new residential customers were identified. The extent to which the costs might be controlled through development of improved methods, equipment and materials was evaluated. The attachment policies used by utilities to qualify residential customers and the decision-making criteria were determined. The information obtained will provide a data base that GRI can use to plan and evaluate R&D projects to reduce customer attachment costs.

24551 **(PB—87-150868/XAB) Advanced furnace concepts - advanced commercial warm-air furnace. Annual report, October 1984-March 1986.** Gotterba, J.A.; Buckley, G.G.; Schreiber, R.J.; Kesselring, J.P. (Alzeta Corp., Mountain View, CA (USA)). Apr 1986. 105p. (REPT—86-720-128). NTIS, PC A06/MF A01.

See also annual report dated Oct 1984, PB—85-176170.

The project's objective is to develop an advanced, condensing commercial warm-air furnace. The furnace uses a gas-fired, low-NOx radiant-fiber burner manufactured by the performing organization. In the first of four projet phases, the retrofit of the burner into a conventional heater resulted in a significant reduction in NOx emissions and noise output. During the second phase, a field retrofit of a condensing heat exchanger onto the Phase 1 furnace was not cost-effective. A prototype advanced condensing furnace was then field-tested during the 1983-84 heating season in an Ohio industrial plant. It demonstrated significant fuel savings as well as identified design considerations for the Phase 3 advanced furnace. The third phase developed an advanced furnace that featured a series-flow condensing heat exchanger. The design achieved an efficiency of 94%. Four of these units were field tested during the 1984-85 heating season. The tests showed that the technology was reliable. Data on combustion air-filtering requirements also was provided. In Phase 4, the furnace technology was scaled to include an entire line of furnaces. All have demonstrated high efficiency and further data on filtering requirements was obtained.

24552 **(PB—87-153888/XAB) Development of a multipurpose construction and maintenance vehicle for the gas industry. Phase 1. Final report, November 1, 1984-March 31, 1986. Engineering prototype.** Chaiko, W.M. (Ingersoll-Rand Research, Inc., Princeton, NJ (USA)). Apr 1986. 189p. NTIS, PC A09/MF A01.

An engineering prototype multipurpose construction and maintenance vehicle (MCMV) was developed for gas utilities to service distribution systems buried under pavement. The vehicle incorporates an abrasive waterjet to cut pavement, a vacuum bell to lift it out, a soft excavation tool to dig without utility damage and a soil stabilizer mixer to prevent pot holes after backfilling. The design is modular to permit a mix of standard-tools techniques with advanced technology. The vehicle is aimed at smallhole operations and a significant cost reduction over current utility truck methods. Cost/benefit analysis indicates the MCMV may be attractive compared to current methods but would be at a competitive disadvantage with new vacuum-truck technology. To become competitive, substantial configuration changes in the MCMV are required.

24553 **(PB—87-154001/XAB) Packaged gas-fueled cogeneration system for hospitals. Final report, September 1982-January 1986.** Gudenkauf, W.M.; Dikeman, D.J. (Martin Cogeneration Systems, Topeka, KS (USA)). May 1986. 116p. NTIS, PC A06/MF A01.

See also report dated Sep 84, PB—85-180487.

The economic opportunity exists today in various markets to show justification for cogenerating electrical and thermal energy in hospitals. Successful development and testing of a low-cost package using commercially available and proven components should result in rapid commercialization. The objective of the project is to design, build, and test a 500-kW reciprocating engine cogeneration package providing 145 tons of absorption cooling, domestic hot water, and space heating on a continuous basis. Design and cost evaluation of the simple package will lead to an understanding of present cost and opportunities for future development.

24554 **(PB—87-154860/XAB) Application analysis for gas-fired cogeneration non-grid power. Final report, September 1985-June 1986.** Lynch, J.D.; Nordahl, T.K.; Wu, F.C. (HPD, Inc., Naperville, IL (USA)). Aug 1986. 63p. (HPD-PCS—8566). NTIS, PC A04/MF A01.

Studies were made in four processing industries to identify specific cogeneration applications closely integrated into chemical-manufacturing processes. For chlor-alkali plants using diaphragm-cell electrolytic processes, cogeneration has been an established practice. In the new membrane-cell process, cogeneration is no longer a viable option. For the production of crystalline chemicals, cogeneration exists for processes employing mechanical vapor-recompression crystallizers with solids dewatering and drying system. Possible application exists for cogeneration system in the reclamation of groundwater using a combination of electrodialysis and evaporation processes. In the pulp and paper industry, freeze crystallization, an emerging technology, offers a unique opportunity for cogeneration application using a gas-fueled refrigeration system integrated to a multiple-effect evaporator system for the concentration of black liquor. Further development of the technology is indicated.

0307 Waste Management

24555 (PB—87-142204/XAB) Impact of one-time dormant season application of gas-well brine to forest land. Research paper. Dewalle, D.R.; Galeone, D.G. (Pennsylvania State Univ., University Park (USA). Davey Lab.). Oct 1986. 27p. (RP—49). NTIS, PC A03/MF A01.

In order to test the feasibility of forest-land disposal of oil and gas waste waters, forest plots in Pennsylvania were treated with a one-time, dormant season application of gas-well brine equivalent to 1.52, 0.69 and 0.17 kg chloride per square meter. One growing season after treatment, little or no mortality of overstory trees had occurred due to treatment. Understory red maple and dogwood saplings suffered 30-40% mortality on the plot receiving 1.52 kg chloride per square meter. Chloride, barium, lead, arsenic, selenium and cadmium in excess of drinking water limits were found in soil water immediately after treatment. Concentrations of all elements, except selenium, declined to safe levels within three months after treatment in zero-tension soil lysimeter water samples.

24556 (PB—87-147484/XAB) Sampling, preservation, and analytical methods research plan - liquid redox sulfur recovery technologies: Stretford process. Topical report. Trofe, T.W. (Radian Corp., Austin, TX (USA)). Nov 1986. 51p. (RAD—86-218-043-11). NTIS, PC A04/MF A01.

GRI has developed a sampling, preservation, and analytical (SP&A) methods research plan for developing and validating analytical methodologies for liquid redox sulfur recovery processes (e.g., Stretford process). The document describes the technical approach which will be used to direct research activities to develop SP&A methodologies to analyze gaseous, aqueous, and solid process streams from the Stretford sulfur recovery process. The primary emphasis is on developing and validating methodologies for analyzing vanadium (IV) and vanadium (V), anthraquinone disulphonic acids (ADA), polysulfide-sulfur, sulfide-sulfur, thiosulfate, sulfate, thiocyanate, total soluble sulfur, alkalinity, pH, total dissolved solids, total suspended solids, and dissolved oxygen in aqueous process streams. The document includes descriptions of the process streams and chemical species, selection of candidate analytical methods, and technical approach for methods development and validation.

0309 Artificial Stimulation

REFER ALSO TO CITATION(S) 24470, 24515, 24543

24557 (SAND—86-2412C) Advances in borehole seismic fracture diagnostics. Thorne, B.J.; Morris, H.E. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 11p. (CONF-870529—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007433.

From Society of Petroleum Engineers meeting on low permeability reservoirs; Denver, CO, USA (18 May 1987).

Recent redesign of the hardware, software, and data-reduction techniques associated with a triaxial Borehole Seismic System have made possible better estimates of hydraulic fracture geometry. The redesigned triaxial system now incorporates three geophones per axis and provides 30 times the downhole gain of the replaced system, resulting in improved signal-to-noise ratios. This stronger signal, together with an increased digitization rate for each of the six simultaneously digitized channels from two borehole seismic tools, has made possible the acquisition and processing of data that were previously inaccessible. The new electronics makes use of a null system and an improved calibration system which includes a synthetic event generator to produce sinusoidal signals of specified amplitude, frequency, and phase. These make readjustments to maintain system balance possible while the tool is in place downhole. A maximum likelihood event location scheme, which incorporates a newly developed algorithm based on the use of directional statistics, is used to compute the location of microseisms and error estimates for these locations. The accuracy of the redesigned system, based on the ability to locate perforation shots, indicates a 25 ft (7.6 m) uncertainty in the location of individual microseisms. This results in a fairly high level of confidence in the determination of the azimuth of the November 1, 1986, hydraulic fracture in the fluvial zone at DOE's Multiwell Experiment Site. 7 refs., 6 figs., 2 tabs.

0310 Legislation And Regulation

REFER ALSO TO CITATION(S) 24921

0320 Transport, Pipelines, And Handling

24558 (PB—87-142444/XAB) Interstate pipeline's annual report of gas supply, 1985 (FERC-15). Data file. Price, R.; Colligan, J. (USDOE Energy Information Administration, Washington, DC). 1985. vp. NTISCP T02.

See also PB—85-128064, and PB—86-146222; Source tape is in the EBCDIC character set. This restricts preparation to 9 track, one-half inch tape only. Call NTIS Computer Products if you have questions.

The computer data tape specified herein contains one file consisting of FERC-15 respondent data for the 1985 report year. The file consists principally of reserves and production data reported in the Synopsis of Gas Supply, Schedule I, and Schedule II of the FERC-15. The Synopsis of Gas Supply and Schedule I contain summary-level reserves and production data reflective of the detailed information contained in Schedule II. The Synopsis of Gas Supply and Schedule I consist of a single page each. All volumes reported on these two forms are on a dry basis at a pressure base of 14.73 psia and 60°. Each unique source of supply is reported in Schedule II. The Schedule II format allows a maximum of five unique sources to be reported on each page, therefore, Schedule II submission may vary from one page to many. The data contained within the file is sorted ascendingly by company code, page number and line number.

0330 Properties

24559 (PB—87-153904/XAB) Liquid-vapor and solid-liquid-vapor equilibrium in natural gas systems. Final report, January 1983-December 1985. Sloan, E.D.; Kidnay, A.J. (Colorado School of Mines, Golden (USA)). Oct 1985. 107p. NTIS, PC A06/MF A01.

See also PB—84-179191.

The three-phase (SLV) equilibria for the methane + carbon dioxide system was measured at 206, 208, 210, 212, 214, and 216 K, and a complete isotherm was determined at 212 K. The ethane + carbon dioxide system was studied at 204, 206, 208, 209, 210, 212, 213, 214, 216 K and complete isotherms determined at 204, 207, 209, 210, 212, and 216 K. The propane + carbon dioxide system was studied at 208, 210, 212, 214, and 216 K with a complete isotherm measured at 216 K. Preliminary data on temperature, pressure, and mole fraction at the triple points are tabulated. Vapor liquid equilibria data are presented for the ethane + carbon dioxide system at 207, 210, 220, 223.15, 230, 250, 263.15, 270, 213, 230, 250, and 270 K. Binary interaction parameters were fit for the Soave-Redlich-Kwong equation of state. VLE measurements are presented for the nitrogen + ethane, and the nitrogen + carbon dioxide system at 220 K and 270 K. Measurements are also presented for the ternary system nitrogen + carbon dioxide + ethane at 220 K and at three pressures ranging from the pressure of 0.803 (the carbon dioxide + ethane azeotrope) to 9 MPa.

0340 Combustion

REFER ALSO TO CITATION(S) 25143, 25496, 25497, 25500

24560 (CONF-8604156—, pp 3-6) **Reminiscences on furnaces and heat transfer, and comments on oxygen-enriched emissivities of flame gases.** Hottel, H.C. (Massachusetts Institute of Technology, Cambridge). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The transcript of the introductory speech of the conference is presented. The speaker gives a brief historical review of the use of natural gas and the technological advances that have been made in that usage. He also briefly discusses combustion properties and emissivity.

24561 (CONF-8604156—, pp 39-48) **Heat-transfer enhancement by pulse combustion in industrial process.** Corliss, J.M.; Putnam, A.A. (Battelle Columbus Lab., OH). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Heat transfer techniques that can be cost effectively applied to industrial processes have been of continuing interest to industry. Increasing the heat-transfer effectiveness of many processes would lead to greater productivity, efficiency, and in some cases, reduced equipment sizes. One such technique being studied at Battelle is the use of pulse-combustion systems in industry. Preliminary results have shown that the heat-transfer coefficient can be augmented by up to 100% with this technique, and that heating surface requirements can be reduced by half. Results also show that when coupled with mass-transfer processes, the use of pulse-combustion technology improves the process by up to a factor of 5. The heat-transfer enhancement in pulse-combustion systems is due to the oscillation of gas flow within the combustion system. This oscillation follows the periodic combustion process that takes place within the system. The periodic nature of the combustion processes results from the acoustic coupling of the system geometry with the natural tendency of flames to oscillate. The resulting synergism causes the system to operate at resonance with an increase in heat-transfer coefficient ranging from up to four times that of steady, nonpulsating systems. This paper describes the results of heat-transfer measurements and calculations performed at Battelle to determine the degree of beneficial effect of heat-transfer enhancement in pulse combustors in industrial processes. Three types of processes are considered. These are (1) immersion heaters, (2) radiant burners, and (3) direct-fired operations. Measurements are described for heat transfer in a pulse-combustion boiler and in a conventional fire-tube type boiler. In these experiments, heat-transfer coefficient enhancement of 100% was measured in the pulse-combustion system. Measurements in a direct-impingement drying experiment are also described. 16 references.

24562 (CONF-8604156—, pp 49-53) **Experimental evaluation of a radiant tube combustion system fired with oxygen enriched combustion air.** Huebner, S.R.; Hersch, C.A.; Lukasiewicz, M.A. (ed.). (Midland-Ross Corp., Toledo, OH). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

This paper discusses the results of testing a gas fired radiant tube combustion system fired with oxygen enriched combustion air. The thermal efficiency of a radiant tube combustion system depends on furnace temperature, the geometry of the radiant tube, the firing rate of the burner and the combustion air oxygen concentration. Because of the large quantity of parameters involved, an experimental approach was selected for determining the effect of oxygen enrichment on radiant tube thermal efficiency. The experiments were performed with a standard radiant tube combustion system as normally used with standard air. The range of furnace temperatures tested was 700°C to 1315°C and the combustion air oxygen concentration varied from 21 to 80%. Radiant tube diameters tested were 0.102, 0.181 and 0.254 m. Various thermal loading conditions were tested to simulate actual firing practices experienced in the field. The results indicated that increasing the oxygen concentration of the combustion air substantially increases the thermal efficiency of the combustion system. Additionally, the increase in flame temperature due to the increase in combustion air oxygen concentration had little effect on the radiant tube or burner materials. The radiant tube temperature is primarily a function of furnace temperature and firing rate. 6 figures, 3 tables.

24563 (CONF-8604156—, pp 55-61) **Applications of pulse combustion in industry.** Zinn, B.T. (Georgia Institute of Technology, Atlanta). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

This paper discusses past and potential industrial applications of pulse combustion. The advantages in utilizing pulse combustors in industrial processes are related to the unique characteristics of these combustors and the presence of pulsations in their exhaust flows. Specific advantages of pulse combustors include: ability to burn various fuels; high combustion intensities; low NO/sub x/ formation; low excess air requirements and self aspiration which eliminates the need for compressors or fans to pump the air and combustion products through the system. Additionally, the presence of pulsations in the exhaust flow enhances the rates of mass, momentum and heat transfer in the process under consideration; improvements which result in increased output and reduced operational costs. To date, pulse combustors have been utilized in such applications as drying, stem raising, heating and so on. In these applications it has been demonstrated that the use of pulse combustors has resulted in capital investment and operational cost savings. Finally, potential applications of pulse combustion in chemical processing, catalytic combustion, gasification and so on are discussed in the paper. 30 references, 4 figures.

24564 (CONF-8604156—, pp 65-70) **Regenerative burners for radiant tubes - field test experience.** Davies, T. (North American Manufacturing Co., Cleveland, OH). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Compact regenerative burners have been developed for both radiant-tube and direct-heating industrial process furnaces. This paper deals with field tests of the radiant tube burner on a continuous galvanizing furnace. 12 figures.

24565 (CONF-8604156—, pp 71-75) **Improved combustion/thermal efficiency with compact recuperator design.** Singh, S.N.; Yokosh, S.; Briselden, T.; Singh, S.S. (WB Combustion, Inc., Milwaukee, WI). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Thermal efficiency of the radiant tube combustion system is improved by utilizing advanced recuperative equipments. These equipments are self recuperative single ended radiant tube and plug-in type recuperators. In order to increase their applicabilities, advanced ceramic materials are being used to manufacture the critical components exposed to higher flue gas temperature i.e. 2000 degrees F. + or 1079 degrees C. Preliminary design methods to manufacture these equipments indicate that ceramic recuperators can compete against conventional single ended and plug-in recuperators. Preliminary test results indicate that a higher preheat temperature from the ceramic recuperator is possible when the plug-in design is used. 3 figures.

24566 (CONF-8604156—, pp 77-85) **ReGen Regenerative Burner for high performance, heat recovery in aggressive environments.** Newby, J.N. (Regen Systems, Inc., Lexington, KY). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The reGen Regenerative Burner, an all ceramic high temperature burner, close coupled to a compact, fast cycle, ceramic regenerator, provides air preheats in excess of 85% of the process temperature in fuel fired applications up to 1650°C (3000°F). The unit is operating without problems in dirty waste gas applications such as aluminum reverberatory melting furnaces and a soda lime glass melting tank, where the exhaust gases contain high volatile and particulate loadings of a corrosive and condensing nature. In these production environments, and others such as ingot reheating for forging which fall on the borderline between dirty and clean waste gas classifications, the substantial performance, life and ease of maintenance advantages of this design and concept over recuperation have been demonstrated on a commercial basis since the first installation on a glass melting furnace in January 1983. This paper describes the equipment, its operating philosophy and performance. Examples of melting and reheating applications in the metals and glass industries will indicate the suitability of reGen for retrofit as well as new construction, and reinforce the flexibility afforded by its design and construction, including multi-fuel capability, high, medium, and low velocity burner designs, and remote mounting of regenerators, and discuss the various cleaning methods used to remove fouling from the regenerator packing. Fuel savings, over cold air operation, ranging from 40% to 65% are reported from applications where well controlled and maintained conditions existed before reGen was installed. These, combined with the no process compromise afforded by reGen's design flexibility, offer the user a cost effective means of addressing exhaust heat recovery in even the toughest applications. 9 figures.

24567 (CONF-8604156—, pp 89-97) **Inviscid model for the prediction of the near field region of swirl burners.** Bortz, S.; Hagiwara, A. (KVB Inc., Irvine, CA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The isothermal phases of the IFRF burner near field aerodynamics project has led to considerable insight into the relationship between the flow field created by an expanding swirling flow and the initial swirl level and the geometry of the confining surfaces. Analytic inviscid solutions to the equations of motion, which indicate that both the initial swirl level and the diameter expansion ratio are important in determining the local flow properties, have been shown to be capable of estimating the initial shape and axial position of the IRZ, as well as the mean velocities in the expanding swirling flow. The analytic solutions have also been used to demonstrate that the internally recirculated mass flow strength should be governed by the parameter $S(b/a)^2$, where S is the initial swirl number and $(b/a)^2$ is the area expansion ratio of the flow. The importance of this parameter has been confirmed experimentally. The influence of varying the Reynolds number in the range 25,000 to 115,000 on the flow field was shown to be small, and the upstream influences of downstream boundary conditions, such as the furnace exist diameter, have been quantified. 4 references, 15 figures.

24568 (CONF-8604156—, pp 99-107) **Flow and combustion modeling of vertical lime kiln chambers.** Khalil, E.E. (Cairo Univ., Egypt). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The applicability of the numerical computational schemes to complex flow and combustion in a vertical lime kiln furnace producing 80 tons/day is discussed. The flow is considered as two-dimensional axisymmetric with solid-gas interactions taken into account. The section describes the calculation procedure and its constituent components. The paper ends with a general discussion and a summary of the more important conclusions and results.

24569 (CONF-8604156—, pp 109-116) **Numerical simulation methodology and its application in natural gas burner design.** Butler, G.W.; Lee, J.; Ushimaru, K.; Bernstein, S.; Gosman, A.D. (Energy International Inc., Bellevue, WA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

A numerical methodology has been developed for the design and analysis of gas-fired combustion systems. The fundamental element of this approach is TEACH-3E/II, a three dimensional numerical simulation code for turbulent flows developed at Imperial College. The simulation technique can treat a wide variety of boundary conditions, is numerically stable at all Reynolds numbers, and can be applied to a broad class of burner geometries and flows. Examples are presented which demonstrate its use as an effective engineering tool for the analysis of fluid dynamics, heat transfer, and the suppression of pollutants in thermal processing systems. 7 references, 10 figures, 2 tables.

24570 (CONF-8604156—, pp 127-134) **Utilization of a numerical model for the design of a gas immersion tube.** Perrin, M.; Lievoux, P.; Borghi, R.; Gonzalez, M. (Gaz de France, Paris). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

A numerical program for the determination of unsteady eddy flow and calculation of heat transfer (convective and radiative) within the flow is presented. After evaluation of experimental results, the model will be used to design new ranges of industrial equipment such as immersion tubes.

24571 (CONF-8604156—, pp 135-141) **Parametric study of the thermal performance of a natural gas-fired furnace.** Song, T.H.; Viskanta, R. (Purdue Univ., West Lafayette, IN). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The effects of furnace design and operating parameters on the thermal performance of a natural gas-fired, high temperature, industrial furnaces have been studied by numerically simulating the flow, combustion and radiative as well as convective heat transfer. The k-epsilon model is used to predict turbulent flow, and Bray's model for premixed combustion is employed. Radiation heat transfer is calculated by accounting for the effects of turbulence/radiation interaction and spectral characteristics of the combustion products. The solution of the model equations is obtained using the SIMPLER algorithm. The results of calculations show that the thermal efficiency of furnace is improved by the increase in the adiabatic flame temperature, increase in the sink emissivity, decrease of sink temperature, oblique firing, and improvement in thermal insulation of refractory walls. 10 references, 7 figures, 7 tables.

24572 (CONF-8604156—, pp 143-150) **Computation of adiabatic flame temperatures and other thermodynamic quantities.** Westbrook, C.K. (Lawrence Livermore National Lab., CA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152. Contract W-7405-ENG-48.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The equilibrium final temperature and composition of a given fuel-oxidizer mixture have both theoretical and practical importance for helping to understand the behavior of combustion systems. Both are needed in order to estimate levels of chemical pollutants such as oxides of nitrogen (NO/sub x/), and the final temperature is necessary to predict the expected thermal efficiency and heating value of a given combustor. Knowledge of the ways that various radical and stable intermediate chemical species vary as operating conditions are changed can also suggest system modifications to improve overall performance. In this paper, the methods available for computing chemical equilibrium conditions such as adiabatic flame temperatures will be reviewed. The dependence of computed values on available thermochemical data bases will be demonstrated. Examples of equilibrium flame temperatures and compositions for mixtures of interest and importance in natural gas combustion will be presented. 8 references, 9 figures.

24573 (CONF-8604156—, pp 153-163) **Technical and economic evaluation of oxygen enriched combustion systems for industrial furnace applications.** Kobayashi, H.; Boyle, J.G.; Keller, J.G.; Patton, J.B.; Jain, R.C. (Union Carbide Corp., Tarrytown, NY). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152. Contract AI07-85ID12579.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Parametric analytical studies were conducted to evaluate the economics and technical requirements of oxygen enriched combustion systems (OEC) and preheated oxygen enriched combustion systems (POEC) for industrial heating applications. The potential for fuel savings and productivity improvements with OEC/POEC systems was analyzed for a broad range of furnace conditions including those for steel reheating, glass melting, and aluminum remelting. The optimum combinations of oxygen enrichment and preheating were investigated considering process constraints and capital and operating costs of POEC systems. The most cost effective methods of supplying oxygen enriched air were evaluated comparing the economics of membrane, PSA and cryogenic systems. The overall process economics of OEC/POEC systems were compared with those of conventional heat recovery systems. 9 references, 10 figures, 4 tables.

24574 (CONF-8604156—, pp 165-170) **Effects of oxygen enrichment on the performance of air-fuel burners.** Joshi, S.V.; Becker, J.S.; Lytle, G.C. (Air Products and Chemicals, Inc., Allentown, PA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

This paper reports on the effects of oxygen off-the-shelf air-fuel burners. In the test, oxygen was mixed with combustion air to achieve oxygen concentrations up to 35%. The reported data include refractory temperature profiles, gas temperature profiles, burner temperatures, burner pressures, and various gas analyses. The data span the entire operating range of the burners.

24575 (CONF-8604156—, pp 171-178) **Pyretron, a variable gas/oxygen/air combustion system.** Gitman, G. (American Combustion, Inc., Atlanta, GA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

This paper presents the engineering principles behind a new variable gas/oxygen/air combustion method called PYRETRON. The Pyretron increases flame luminosity and velocity by using oxygen to accelerate the pyrolysis of natural gas inside an extremely hot flame core contained in a specially structured and controllable flame envelope. In addition, the system provides increased controllability of the chemical inputs to provide for an excess hot oxidizer when needed for refining or to reduce the oxidation ability of combustion products when they will negatively impact product quality. These advances have applications in the melting of copper, steel and aluminum, in the forging and rolling of steel where the process is sensitive to combustion products and in processes such as the melting of glass and the heating of ceramic products where both the product and the furnace are sensitive to uneven temperature distribution. The paper specifically illustrates the operating advances of the Pyretron from experience gained in steel making applications. 1 reference, 6 figures, 1 table.

24576 (CONF-8604156—, pp 179-185) **Key factors affecting the economics of oxygen enriched air production via membranes.** Gollan, A.; Kleper, M.H. (A/G Technology Corp., Needham, MA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152. Contract AC07-83ID12429.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The benefits of oxygen enriched air for improving combustion efficiency and overall productivity in industrial heating applications is well documented, however the adoption of this technology by industry has been very limited due to the high costs of delivered oxygen or on-site generation. An advanced hollow fiber membrane technique for on-site oxygen generation has been developed which holds promise of being the most cost-effective method of generating up to 40% oxygen enriched air. In this paper, the factors which affect the economics and power requirements of this membrane air separation process are discussed. These factors include intrinsic membrane properties, mode of operation, scale of operation, temperature and oxygen concentration. In addition, the general advantages of membrane systems over alternative oxygen generation schemes are discussed. 10 references, 7 figures.

24577 (CONF-8604156—, pp 187-196) **Combustion characteristics of fuels with preheated oxygen enriched air.** Guerrero, P.S.; Rebello, W.J.; Ally, M.R.; Jain, R. (PAR Enterprises, Inc., Fairfax, VA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152. Contract AC01-84CE40716.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Enriching air with oxygen in furnace combustion systems can significantly increase the thermal efficiency of the system and contribute to a savings in fuel and an increase in productivity. If economic feasibility is proven for a given application, the only other potential barrier to the use of oxygen enrichment in industrial combustion processes could be the increase in NO/sub x/ formation due to the higher flame temperatures. The objectives of this work were to determine the maximum flame temperatures resulting from the combustion of various solid, liquid and gaseous fuels with preheated oxygen enriched air, to determine the maximum (equilibrium) levels of pollutant (NO/sub x/) concentrations and to predict actual levels of NO/sub x/ that could be expected in typical industrial furnaces. The computer program considered thirteen dissociating species, preheat temperatures up to 2000°F and oxygen enrichment levels varying from 21% to 50% oxygen. The results indicate that for natural gas above flame temperature of 5165°F, the equilibrium NO/sub x/ values tend to decrease with high levels of oxygen and high preheat temperatures because other dissociating reactions predominate at these high temperatures. A methodology was developed, using kinetics, to predict the actual NO/sub x/ expected in a typical furnace. The predicted values of NO/sub x/ were compared with measured values for an experimental furnace and found to be in general agreement. Though there are no New Source Performance Standards for industrial furnaces, the analysis indicates that for combustion of natural gas with preheated oxygen enriched air, the NO/sub x/ formed would be considerably more than the NSPS for an industrial steam generator of 0.2 lbs NO_2/million BTU. 12 references, 12 figures, 3 tables.

24578 (CONF-8604156—, pp 199-203) **Infrared based fuel/air control for boilers fired with natural gas.** Zabielski, M.F.; Daigle, L.J.L. (United Technologies Research Center, East Hartford, CT). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

A fuel/air controller, based on results obtained with a laboratory scale controller, has been designed and constructed to trim the fuel/air ratio of small packaged boilers (1.0-5.0 MBTU/HR). The principal elements of the controller are: a MACSYM 120 process control computer, an interface chassis, a lead selenide infrared detector, a variable length control rod, and a fuel flow modulator. The fuel flow modulator is used to introduce a small variation in the flame so that phase sensitive detection can be performed on the infrared signal. Phase sensitive detection is used to distinguish the flame emission from the background radiation. The infrared detector is a lead selenide type which senses the radiation from CO_2 in the 4.3 micron region. A variable length control rod is used to trim the primary air flow. All tasks associated with open and closed loop operation are performed by the computer through a general purpose interface chassis. The software includes a routine that does phase sensitive processing with automatic phase tracking. A description of the controller elements is given along with preliminary results obtained in a field test of the controller. 7 references, 7 figures.

24579 (CONF-8604156—, pp 205-212) **COMBURIMETRE and its use in combustion control.** Benisti, J.; Vabre, C.; Chapus, A. (Gaz de France, Paris). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

In any gas-fired industrial installation, improvement of production quality and overall efficiency requires adequate combustion control. Any combustion requires a well defined combustion agent/fuel feed ratio. Control of this ratio is generally done through analysis of the combustion products. If the combustion products are polluted or not accessible it is necessary to know the fuel characteristics in order to maintain unchanged, by upstream action, the ideal conditions for combustion when those characteristics vary. The fact that a specific sensor is not commercially available has led Gaz de France to develop a meter called COMBURIMETRE in cooperation with a manufacturer. The COMBURIMETRE is a combustion simulator which enables the continuous measurement of an important characteristic of distributed natural gas: the combustion air requirement index (B) which is defined as $B = Va/\sqrt{d}$ where Va is theoretical air requirement (unit $m^3(n)$ of air/$m^3(n)$ of gas) and d relative density with respect to air. Marked as of three years ago, the COMBURIMETRE has proven its reliability, accuracy and speed of response, and therefore its capacity to control combustion in the most sensitive industrial processes. Furthermore, the tight analogy which exists between the combustion air requirement index ($B = Va/\sqrt{d}$) and the Wobbe number ($W = gcv/\sqrt{d}$) of natural gases allows using the COMBURIMETRE to regulate a constant thermal input under the same conditions. This paper consists of two parts, after presenting the characteristics of the unit, they shall emphasize the various regulation schemes using the COMBURIMETRE, and give some application examples. 9 figures.

24580 (CONF-8604156—, pp 213-220) **Technologies for low cost combustion control.** Burk, N.; Woolbert, G. (Bailey Controls Co., Wickliffe, OH). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

In the past ten years there have been significant advances in technologies that are relevant to improving gas-fired combustion controls for industrial applications. These technologies include sensors, electronics, and packaging. Sensors that can measure the constituents in the products of combustion (e.g., CO and O_2) can be made less expensive, more reliable, and require less effort in calibration and maintenance. The use of digital technology in the electronics area has substantially reduced the electronics cost while increasing its functional capability and reliability. Lower-cost fabrication and packaging techniques are available now because of the use of new materials and manufacturing processes. Combining these technologies can result in a combustion controller that is significantly lower in cost than existing devices and therefore applicable to a much wider range of applications. In this paper, the characteristics of such a controller are described and the benefits that will accrue to the natural gas industry are summarized. 3 figures.

24581 (CONF-8604156—, pp 221-227) **Spectral flame analyzer for combustion control in industrial boilers.** Batra, S.K.; Cole, W.E.; Metcalfe, C.I. (Thermo Electgron Corp., Waltham, MA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

This paper describes the principle of operation of the Spectral Flame Analyzer test results in the MIT Combustion Research facility. The instrument is used to maintain optimum combustion control to increase efficiency and to lower pollutant emission. The paper also discusses the development program for industrial application and potential benefits of this technology.

24582 (CONF-8604156—, pp 229-241) **Flue gas stratification in industrial and utility boilers.** Cooper, M.H.; Jahn, R.K. (Bailey Controls Co., Wickliffe, OH). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Two independent projects, sponsored separately by the Department of Energy and the Electric Power Research Institute, put in place to prove the existence of flue gas stratification in industrial and utility type boilers are discussed. The objective of these projects was to demonstrate the feasibility of using the analysis of stratified flue gas as a guide to more precise adjustment of burners, thereby increasing the fuel efficiency of multiple burner combustion equipment.

24583 (CONF-8604156—, pp 245-251) **Oxygen techniques in combustion processes: a review of practical case studies within the BOC group.** Hall, R.M. (BOC Ltd., Baildon, England). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The different oxygen techniques used in natural gas combustion are discussed with an emphasis on using pure oxygen rather than nitrogen-oxygen mixes. Advantages of oxygen systems are given, along with methods of oxygen usage and several case studies.

24584 (CONF-8604156—, pp 253-257) **Ferrous metal heat treating - a comparison of natural gas and alternative technologies.** Koch, G.S.; Williams, J.H. (Hagler, Bailly & Co., Washington, DC). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Ferrous metal heat treating technologies are identified for the following categories: through heat treating and selective heat treating. Current market profiles are developed for the various ferrous metal heat treating technologies segmented by furnace type and process type. Preliminary findings show an estimated population of over 52,000 heat treating furnaces. Of these, approximately 55% are fossil fuel-fired batch technologies (mainly natural gas), 15% are fossil fuel-fired continuous technologies, and 30% are electric induction technologies. Significant R & D opportunities for improving the competitiveness of natural gas in the ferrous metal heat treating market are explored. 2 figures, 3 tables.

24585 (CONF-8604156—, pp 259-265) **Demonstrated fuel savings and uniform heating with 100% oxygen burners in a continuous steel reheat furnace.** Walsh, L.T.; Ho, M.; Ding, M.G. (Union Carbide Corp., Tarrytown, NY). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The Linde A Burner System is a patented oxygen-fuel combustion system developed for fuel savings and productivity increases in high temperature process furnaces such as soaking pits and batch or continuous reheating furnaces. The unique design of the burner enables the use of 100% oxygen in a wide variety of furnaces without creating a localized high temperature flame. This paper discusses the results of the first installation in a continuous steel reheat furnace.

24586 (CONF-8604156—, pp 267-271) **Industrial applications of the pyrocore burner.** Krill, W.V.; Pam, R. (Alzeta Corp., Santa Clara, CA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The Pyrocore burner has undergone development to extend its use from residential sizes up to industrial applications. Initially developed under sponsorship of the US Environmental Protection Agency and subsequently more extensively by the Gas Research Institute, the problems of constructing and operating a large radiant surface burner were overcome. Large, segmented cylindrical burners were first developed for firetube steam boilers and later extended to more general immersion tube applications. The extended cylindrical surface provides a very uniform, highly radiant heat flux to the tube wall. This feature allows process efficiencies to be enhanced by avoiding high temperature zones in heating equipment. The burner can be made in a variety of lengths and diameters and other configurations to match heating needs. The low temperature combustion process produces very low nitrogen oxide (NO/sub x/) emissions - important in regions of regulated air quality. In addition to steam raising in firetube boilers, the Pyrocore immersion tube burner is finding applications in heating fluids that are sensitive to degradation at high temperatures or excessive local heat fluxes. Examples are: asphalt tank and line heaters; glycol heaters for natural gas dehydration; heat transfer fluid and oil heaters; crude oil treating; salt bath heaters. In boiler applications, a 1 to 2 percentage point efficiency improvement is common with reduced NO/sub x/ emissions and the elimination of flame noise. In petrochemical processes, higher heating rates to the fluid can also increase production rates from an existing piece of equipment. Data show enhanced life of the heated fluid and the heater firing tube. 6 figures.

24587 (CONF-8604156—, pp 273-277) **Innovative techniques in the glass industry.** Freeman, R.A. (Stordy Combustion Engineering Ltd., Wombourne, England). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Three innovative combustion techniques in the glass industry are discussed. The first is heat treatment lehrs and in-line exhaust machines, a heat treating technique to remove structural tensions within glass. The second is new firing techniques, particularly the gas fired Ceramic Fibre Matrix Burners. The third technique is regenerative burner systems on glass tanks for use in steel processing applications, aluminum melting, holding furnaces and ladle heating.

24588 (CONF-8604156—, pp 279-294) **Fabricability and design considerations of heat resistant alloys.** Skarda, J. (Rolled Alloyed Inc., Temperance, MI). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The factors affecting environment resistance thermal fatigue, shock resistance and fabricability of heat resisting alloys as used in thermal processing equipment in heat treating equipment. A review of metal properties as related to design considerations and fuel efficiencies in muffles, retorts, fixtures and radiant tubes. The surface characteristics of oxidation, green rot and metal dusting as affected by environments, sigma formation, are reviewed with general guidelines for fabrication and welding techniques. 11 figures.

24589 (CONF-8604156—, pp 295-301) **Characterization of natural gas-fired and alternative steel reheat technologies.** Koch, G.S.; Williams, J.H. (Hagler, Bailly & Co., Washington, DC). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

A current market profile is developed for the following natural gas-fired and alternative steel reheat technologies: walking beam, pusher, batch, and induction. The entire natural gas reheat market currently is approximately 135 x 10^{12} Btu per year out of a total potential reheat market of 187 x 10^{12} Btu per year. Future steel industry structural and technological trends are examined for potential impacts on the natural gas reheat market. The most important impacts will result from future implementation of hot charging, direct rolling, and thin strip casting. R & D opportunities for improving the competitiveness of gas-fired reheat technologies are discussed, including research in combustion fundamentals and furnace design, development of improved sensors and controls, and distribution of information to industry users. 4 references, 1 figure, 4 tables.

24590 (CONF-8604156—, pp 305-311) **Advanced materials development for radiant tube applications.** Liang, W.W.; Schreiner, M.E. (Gas Research Institute, Chicago, IL). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Gas Research Institute, GRI, is supporting the development of innovative advances in the state-of-the-art for natural gas-fired industrial process heating and melting equipment. The Industrial Utilization Research Department of GRI is currently planning to fund multiple projects for the development of systems capable of providing furnace temperatures in the range of 1100 to 1450°C (2000 to 2600°F). These systems will be required to provide a minimum peak heat flux of 91 kW/m^2 (200 Btu/Hr/In^2) within this temperature range in order to effectively compete with comparable electric resistance heating technology. To remain cost competitive with electricity these systems must be at least 65% efficient to take advantage of the existing electricity to natural gas price ratio. System first cost and required maintenance costs must also be competitive with existing gas-fired systems and comparable electrically heated systems. The basic components of an advanced indirect gas-fired heating system include burners, heat transfer surface, and house the combustion flame and its oxidizing by-products. This paper attempts to review state-of-the-art and emerging advanced materials including high temperature alloys, monolithic ceramics and fiber-reinforced ceramic matrix composites. A series of development projects involving ceramic and composite materials, and component development for radiant tube applications will be discussed. 6 references, 3 figures, 5 tables.

24591 (CONF-8604156—, pp 353-354) **Panel session: future directions in industrial combustion research.** Lukasiewicz, M.A. (Gas Research Institute, Chicago, IL). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

A summary of a panel session on the future directions of industrial combustion research is presented. Future projects to be funded by the Gas Research Institute are briefly discussed, along with the US Department of Energy's Office of Industrial Programs projects.

24592 **(PB—87-153979/XAB) Gas-fired indirect heating and melting systems. Appendix C. Topical report, April 1985-May 1986.** Bortz, S.A. (IIT Research Inst., Chicago, IL (USA)). Jun 1986. 65p. (IITRI-M—08260-3). NTIS, PC A04/MF A01.

See also PB—87-153961.

Advanced natural gas-fired indirect heating and melting systems potentially offer great advantages over conventional heating and melting systems. The report reviews developments in high-temperature engineering materials and advanced-system designs and their role in evolving highly efficient and cost-effective indirect heating and melting systems for existing and new industrial processes. Present ceramic materials development is capable of producing radiant heater tubes operable to 3000 F, well beyond the limit for metallic materials, and silicon carbide is thus far the best material for this application. Further work is needed to improve properties, advance material and component technology, and reduce costs. Recommendations are given for achieving these goals and planning for future development of advanced gas-fired industrial process systems.

24593 **(PB—87-153987/XAB) High temperature materials technology for industrial energy systems and processes. Final report, April 1984-May 1986.** Bortz, S.A. (IIT Research Inst., Chicago, IL (USA)). Jun 1986. 86p. (IITRI-M—08260-4). NTIS, PC A05/MF A01.

See also PB—87-153979.

GRI is pursuing new technologies that will improve the performance of natural gas in industrial processes and enable natural gas to be competitive in the industrial sector with other energy alternatives. The program focused on three areas of interest that require establishing a ceramic materials data base for technical input to GRI's R&D planning efforts. These areas are: Ceramics for Heat-Exchanger Applications in High-Temperature Corrosive Flue Streams; Advanced Material and Component Technology for Gas-Fueled Prime Movers; and Gas-Fired Indirect Heating and Melting Systems.

24594 **(PB—87-153995/XAB) Measurement of emission rates from gas-fired space heaters. Final report, June 1984-December 1985.** Zawacki, T.S.; Cole, J.T.; Jasionowski, W.J.; Macriss, R.A. (Institute of Gas Technology, Chicago, IL (USA)). Oct 1986. 162p. NTIS, PC A08/MF A01.

Emission-factor data of nitrogen dioxide (NO_2), nitrogen oxide (NO), carbon monoxide (CO) and unburned hydrocarbons (UBH) were experimentally determined for each of 10 different unvented gas space heaters (UVGSH) by each of 3 different measurement methodologies (probe, hood, chamber). The heaters were of various designs (blue-flame with/without radiating tiles, infrared) and were fueled by natural gas or liquid propane gas (LPG) at various gas input rates (10,000 to 40,000 Btu/h). Emission factors were found to be dependent primarily on heater design (blue-flame vs. infrared) and method of measurement and secondarily on other factors. Emission obtained by the probe or hood method were almost identical but different than obtained by the chamber method, especially emission factors for NO and CO. These differences were investigated and it was concluded that they were caused by the vitiated atmosphere maintained within the chamber at the low (0.5 air changes per hour) chamber air infiltration prescribed as part of the chamber methodology.

24595 **The spontaneous Raman scattering technique applied to nonpremixed flames of methane.** Dibble, R.W.; Masri, A.R.; Bilger, R.W. (Sandia National Labs., Livermore, CA). *Combustion and Flame;* 67: No. 3, 189-206(Mar 1987).

Simultaneous space- and time-resolved measurements of the concentrations of CH/sub 4/, O/sub 2/, N/sub 2/, H/sub 2/O, H/sub 2/, CO, and CO/sub 2/ have been made using spontaneous Raman scattering, in the blue regions of CH/sub 4/ turbulent nonpremixed flames. The temperature is measured from the Rayleigh scattered signal. A "fluorescence" interference, which is broadband and contaminates in varying degrees the Rayleigh and all the Raman lines, is believed to be due to a number of molecules or flame radicals, including C/sub 2/ and CN or even incandescence of small particle nuclei. The "fluorescence" has been monitored at a bandhead of C/sub 2/(516.5 nm) and its effect reduced by placing a Polaroid filter at the entrance slit of the spectrometer. The remaining "fluorescence" has been corrected for, using correction curves generated from measurements made in a laminar counterflow CH/sub 4/ diffusion flame and a diluted CH/sub 4//N/sub 2/ = 1/2 (by vol.) laminar diffusion flame. Measurements of CO and CO/sub 2/ are not reliable in the rich regions of the flame where the "fluorescence" is intense. With minor modifications to the optical system, CO and CO/sub 2/ could also be measured with acceptable accuracy in regions of intense "fluorescence" and the "fluorescence" correction further refined. This work is considered to be an important extension of the applications of spontaneous Raman scattering as a measurement technique in flames.

0350 Storage

24596 **(PB—87-153912/XAB) Development of polymer concrete for dike insulation at LNG (liquid natural gas) facilities. Phase 2. Final report, June 1, 1985-August 31, 1986.** Fontana, J.J.; Cheng, H.C.; Steinberg, M.; Reams, W.; Elling, D. (Brookhaven National Lab., Upton, NY (USA)). Dec 1986. 68p. NTIS, PC A04/MF A01.

See also PB—85-149821.

Insulating polymer concrete (IPC) composites were developed for use as a dike insulation material at Liquified Natural Gas (LNG) storage facilities. Using inert, low density spheres containing a multiplicity of minute independent closed air cells surrounded by a unique tough outer shell and unsaturated polyester or epoxy resins, a new class of lightweight polymer concretes can be manufactured. The IPC composites have low thermal conductivities ranging from 0.02 to 0.15 Btu/hr-ft-deg F over a temperature range of -235 to +90 deg F. With low water absorptions (<1%), these composites are impermeable to rain or snow. The low density app. 50 lbs per cubic foot composites exhibit exceptionally high compressive strengths of 2600 to 3600 psi.

04 OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 24394

0402 Site Geology And Hydrology

REFER ALSO TO CITATION(S) 24395

0404 Oil Production, Recovery, And Refining

REFER ALSO TO CITATION(S) 24395, 24425, 24434, 24434, 24607

24597 **(DOE/FE/60177—2300) Effects of pressure, mineral decomposition and particle size distribution on oil shale compaction.** Fahy, L.J. (Western Research Inst., Laramie, WY (USA)). Aug 1986. Contract FC21-83FE60177. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007915.

Porosity and permeability reduction during oil shale retorting is well documented in the literature. The reduction in permeability has been observed in low void vertical modified in situ (VMIS) field experiments with adverse effects. Mechanical forces caused by the weight of the overlying shale can equal 100 psi near the bottom of commercial retorts. Postburn investigation of the Rio Blanco retorts at the C-a lease tract in Colorado shows evidence of compaction occurring. Western Research Institute is conducting research to study compaction of large oil shale blocks. The data presently available suggest that most oil shale compaction occurs during retorting between 600 and 800°F and that significant amounts of compaction may occur in regions of VMIS retorts where 30 gallon per ton or richer oil shale is retorted. Recent oil shale compaction research has studied the effects of pressure, mineral decomposition, and a wide particle size distribution on oil shale compaction. Results from these tests indicate that compaction increases with an increase in overburden pressure. However, the weight of the rubble column is sufficient to cause compaction of the richer oil shales throughout a VMIS retort. Mineral decomposition and particle size distribution have little effect on the overall compaction of the spent shale. 14 refs., 5 figs., 3 tabs.

24598 **(DOE/LC/11086—2296) The development of the KENTORT II process for eastern US oil shale: Progress report for the period of October 1-December 31, 1986.** Carter, S.D.; Rubel, A.M. (Kentucky Energy Cabinet Lab., Lexington (USA)). Feb 1987. Contract FC21-86LC11086. 32p. (KECL—87-160). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008080.

This report summarizes the progress made on the development of the KENTORT II process during the period of October 1, 1986 through December 31, 1986. The KENTORT II development program is being conducted under Cooperative Agreement No.: DE-FC21-86LC11086 between the Kentucky Energy Cabinet and the Laramie Project Office of the Morgantown Energy Technology Center, US Dept. of Energy. KENTORT II is a multiple fluidized bed process which is designed to optimally utilize the carbonaceous material in eastern US oil shale as an energy source and to reduce the environmental problems associated with such shale processing. The process includes separate stages of pyrolysis, gasification, and combustion with combined solid and gas heat transfer among the stages. During this quarter, a cold-flow model of the pyrolysis and gasification stages of the mini-pilot plant reactor system was constructed and tested. The design of the reactor system was found to be basically sound, and with minor modifications stable operation of the model throughout the range of design conditions was achieved. An aerated solids feeding device was developed which effectively controls the shale recirculation rate. Additionally, an independent method was developed to measure the recirculation rate of the solids. Continuous, stable recirculation of shale char between the two fluidized beds was demonstrated for an 18 hour period. Also during the quarter, the bench-scale fluidized bed reactor was modified for the gasification kinetics investigation of oil shale char. Initial shakedown runs indicated proper operation of the unit throughout the range of operating conditions to be studied. 10 refs., 13 figs., 1 tab.

24599 **Method for in situ heating hydrocarbonaceous formations.** Little, W.E.; McLendon, T.R. (to Dept. of Energy). US Patent Application 6-867,125. 27 May 1986. 14p. DE87007257 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007257.

A method for extracting valuable constituents from underground hydrocarbonaceous deposits such as heavy crude, tar sands and oil shale is disclosed. Initially, a stratum containing a rich deposit is hydraulically fractured to form a horizontally extending fracture plane. A conducting liquid and proppant are then injected into the fracture plane to form a conducting plate. Electrical excitations are then introduced into the stratum adjacent the conducting plate to retort the rich stratum along the conducting plate. The valuable constituents from the stratum adjacent the conducting plate are then recovered. Subsequently, the remainder of the deposit is also combustion retorted to further recover valuable constituents from the deposit. Various rf heating systems are also disclosed for use in the present invention. 5 figs.

24600 **Effect of internally generated bulk flow on the rates of gas-solid reactions. I. Development of a approximate solution.** Sohn, H.Y.; Braun, R.L. (Univ. of Utah, Salt Lake City). *Industrial and Engineering Chemistry Process Design and Development;* **23**: No. 4, 685-691(1983). Contract W-7405-ENG-48.

The rate of reaction between a solid and a gas can be substantially slowed when accompanied by an outward bulk flow of a nonreacting gas. Such a gas may be generated by an independent decomposition reaction involving a second solid. The effect of the latter is analyzed theoretically. The authors have developed a useful approximate method of solution that makes the numerical solution of a second-order differential equation unnecessary. The approximate solution is especially useful in the analysis of multiparticle systems with a wide size distribution. The immediate problem that provided motivation for this work was the analysis of the combustion and gasification by oxygen and steam of oil shale char in a retorted shale block containing carbonate minerals. Other applications include the combustion and gasification of coal containing volatiles, the carbothermal reduction of metal oxides in a carbon dioxide/monoxide-containing atmosphere, and the removal of sulfur-containing gases with dolomite. 23 references, 13 figures.

0405 Properties And Composition

REFER ALSO TO CITATION(S) 24603, 26015

24601 **(DOE/BC/10525—16) Mechanisms of syncrude/synfuel degradation: Fourth and final report, October 1, 1984-December 31, 1986.** Beal, E.J.; Cooney, J.V.; Hazlett, R.N.; Morris, R.E.; Mushrush, G.W.; Beaver, B..; Hardy, D.R. (Naval Research Lab., Washington, DC (USA)). Apr 1987. Contract AI19-81BC10525. 146p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87001232.

Much of the effort during the final period of this project dealt with interactions between co-dopants added to a stable shale derived diesel fuel. Five classes of nitrogen compounds have been examined in detail. A substituted pyridine and a substituted quinoline behave similarly, exhibiting only minor interactions with t-butylhydroperoxide (TBHP), organic bases and weak organic acids, but forming large amounts of insolubles with a sulfonic acid. Dimethylpyrrole (DMP) interacted strongly with TBHP, weak and strong organic acids to produce increased amounts of sediments but interacted only weakly with organic bases. 3-Methylindole exhibited interaction behavior similar to DMP but the positive interaction was significantly enhanced by venting of sample flasks. Dodecahydrocarbazole showed a distinctive pattern of behavior, a strong positive increase in insolubles with TBHP or tributylamine but a substantial decrease with acids, both carboxylic and sulfonic. Widely used fuel stabilizers were ineffective in reducing sediment formation by 2,5-DMP. An intermediate stream from a shale refining process was moderately stable although it was high in nitrogen content, (2290 ppM w/v). Consecutive treatments with dilute HCl and silica gel significantly improved the stability of this liquid. The extracts contained substantial amounts of pyridines and tetrahydroquinolines with smaller amounts of hydrocarbons and other nitrogen compounds. The most polar of the extracts, that stripped from the silicagel by methanol, was a potent sediment producer, on par with DMP on an equivalent nitrogen basis. Light scattering easily detected formation of larger molecules for stressed shale derived diesel fuel containing DMP. However, formation of copious amounts of insolubles prevented the use of this technique as a useful quantitative tool for evaluating fuel instability. 42 refs., 5 figs., 54 tabs.

24602 **(DOE/FE/60177—2307) Bonding energies of bitumen to tar sand mineral.** Ensley, E.K.; Scott, M.A. (Western Research Inst., Laramie, WY (USA)). Mar 1986. Contract FC21-83FE60177. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008437.

The bonding energy of bitumen in a tar sand was found by algebraically adding the heat of dissolution of bitumen on tar sand, heat of dissolution of recovered bitumen and the heat of wetting of extracted tar sand mineral. The value for an Asphalt Ridge tar sand was found to be 270 cal/mole. 6 refs., 3 figs.

0407 Health And Safety

REFER ALSO TO CITATION(S) 25994

0408 Marketing And Economics

REFER ALSO TO CITATION(S) 24603

0409 Waste Research And Management

24603 **(DOE/FE/60177—2299) Leach potential of processed shale as determined by two extraction methods.** Donovan, R.C.; Sorini, S.S. (Western Research Inst., Laramie, WY (USA)). Jan 1985. Contract FC21-83FE60177. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007389.

Batch leach tests were performed on 12 samples of Green River Formation spent oil shales generated from four retorting processes. Two standard leaching procedures were used, ASTM (American Standard Testing and Materials) method D3987 and EPA/RCRA (Environmental Protection Agency/Resource Conservation and Recovery Act) extraction procedure. The trace elements arsenic, boron, cadmium, chromium, molybdenum, lead, and selenium were of interest, as were sulfate and chloride anions. The different leaching media used in the ASTM and EPA methods appear to account for the major differences in the leachates extracted from identical oil shale wastes. The EPA extraction medium is acidic (.1N acetic acid solution) and, thus, is capable of mobilizing significantly more arsenic, cadmium, chromium, lead, and selenium from processed oil shale. Molybdenum, however, becomes more mobile at greater pH values. The amount of boron in leachates appears to be dependent on the temperature at which the oil shale is retorted. The anions SO_4^{2-} and Cl^- in processed oil shale leachates are influenced most by retorting atmosphere and leaching time, respectively. According to RCRA guidelines the concentrations of arsenic, cadmium, chromium, lead, and selenium in the leachates of all the processed oil shale studied are considered nonhazardous. 31 refs., 15 figs., 10 tabs.

24604 **(DOE/FE/60177—2303) Impact of oxidation and reduction on the leaching potential of trace metals from spent oil shale.** Sullivan, P.J.; Carroll, R.B. (Western Research Inst., Laramie, WY (USA)). Dec 1985. Contract FC21-83FE60177. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008056.

The long-term quality of water produced at spent oil shale disposal facilities is a critical concern. Understanding the release and mobility of trace elements as natural weathering of the disposal pile occurs is particularly important. Because spent oil shale leachates are highly alkaline, weathering reactions that increase leachate acidity, thus trace element release and mobility, must be characterized. In order to simulate weathering environments that would occur in a waste disposal pile (i.e., saturated and unsaturated groundwater environments), spent oil shale has been leached under saturated and unsaturated conditions. Unsaturated conditions (an oxidizing environment) allow the oxidation of iron sulfides and adsorption of carbon dioxide. Saturated leaching conditions (a reducing environment) should not allow the acid generation by oxidation or carbon dioxide adsorption. Both of these conditions generate hydrogen ions and should reduce pH in spent oil shale leachate. Spent oil shale was leached for six weeks and the leachate analyzed for pH, sulfates, arsenic, boron, cadimum, calcium, copper, lithium, magnesium, manganese, sodium, strontium, and zinc. The leaching studies indicate that the oxidizing simulation did not significantly decrease the leachate pH, and under reducing conditions the greatest concentration of trace elements were leached from the shale. The trace elements extracted from the spent oil shale in the greatest concentrations are all soluble in high pH solutions. These results indicate that spent oil shale disposal piles in arid to semiarid environments may maintain an alkaline pH because of an extremely high alkaline buffering capacity. These data also indicate that research on carbon dioxide absorption is needed to assess the long-term contribution of acidity to modify solution pH and trace element mobility. 15 refs., 2 tabs.

0410 Environmental Aspects

24605 **(DOE/ER/60071—1) Persistence of biologically active compounds in aquatic systems: Final report.** Boelter, A.M.; Fernandez, J.D.; Meyer, J.S.; Sanchez, D.A.; Bergman, H.L. (Wyoming Univ., Laramie (USA). Fish Physiology and Toxicology Lab.). Nov 1986. Contract AC02-82ER60071. 56p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007752.

Waters collected from two study sites were tested for persistence of biologically active compounds as the waters percolated through experimental media. At the first site, the Paraho Lysimeter in Anvil Points, Colorado, two leachate samples (early and late flow in Spring 1983) were collected from each of four piles of processed oil shale overlain by different thicknesses of soil. Although water quality differed among samples, six of eight lysimeter leachates tested were acutely toxic to an aquatic invertebrate, Daphnia magna, and five were acutely toxic to fathead minnows (Pimephales promelas). Water collected from a modified in situ (MIS) retort was percolated through columns containing three different types of soil. Raw leachate from the MIS spent shale was acutely toxic to an aquatic invertebrate, Ceriodaphnia dubia. The toxicity of samples from nine pore volumes of retort water percolating through a column containing a sandy soil increased with successive pore volumes, but leachate toxicity never equaled the toxicity of the retort water. In contrast, the first pore volumes of retort water or reconstituted water leached through a sandy loam soil were more toxic than the retort water; however, the second pore volumes of leachates were not toxic. First pore volume leachates of retort water percolating through a sandy clay loam soil were much less toxic than the retort water; second pore volume leachates were not toxic.

24606 **(PB—87-147195/XAB) Control of sulfur emissions from oil-shale retorting using spent-shale absorption pilot-plant testing.** VanZanten, K.D.; Chiaramonte, G.R.; Bates, E.R. (J and A Associates, Inc., Golden, CO (USA)). Jan 1987. 16p. NTIS, PC A02/MF A01.

See also PB—87-110516.

The paper discusses an investigation of the environmental advantages/disadvantages of absorbing SO_2 onto combusted retorted oil shale. The objective of the program was to obtain more information in support of EPA's PSD (Prevention of Significant Deterioration) permitting decisions on sulfur control and to investigate whether emission of other pollutants such as NOx and trace elements might be significantly increased in the process. Based on pilot plant data obtained in the study, fluid-bed operating conditions are recommended to optimize SO_2 and NOx control. In general, conditions that favor low SO_2 emissions also favor low CO and trace hydrocarbon emissions, but do not favor low NOx emissions. The study indicates that the conditions chosen for the conceptual design are reasonable and (in most cases) conservative.

24607 **(PB—87-147229/XAB) Effect of oil shale recovery processes on air emissions.** Taback, H.; Goldstick, R.; Bates, E. (Metcalf and Eddy, Inc., Boston, MA (USA)). Jan 1987. 30p. NTIS, PC A03/MF A01.

The paper discusses the effect of oil-shale-recovery processes on air emissions. In developing the analysis for this process comparison, the EPA's Pollution Control Technical Manuals (PCTMs) for various oil-shale processes and various PSD Permit Applications were used. The PCTMs present a comprehensive analysis of the heat and material flows in a complete oil shale-recovery process. The PSD applications provide controlled air-emissions for the specific process considered by the developer. This, the comparison presented in the paper is based on the actual design conditions expected in a full-scale operation. The basic conclusion derived from the analysis is that, although the air emission levels for the different retort processes with controls considered to be Best Available Control Technology (BACT) can vary considerably, sometimes by as much as two orders of magnitude, the application of control techniques that are either improvements over existing technology or more suitable for a specific application, results in similar emission levels for all five processes considered.

05 NUCLEAR FUELS

0504 Feed Processing

REFER ALSO TO CITATION(S) 24622

0505 Uranium Enrichment

24608 **Liquid-phase thermal diffusion isotope separation apparatus and method having tapered column.** Rutherford, W.M. (to Dept. of Energy). US Patent Application 6-804,413. 4 Dec 1985. 22p. Contract AC04-76DP00053. DE87007284 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007284.

A thermal diffusion counterflow method and apparatus for separating isotopes in solution in which the solution is confined in a long, narrow, vertical slit which tapers from bottom to top. The variation in the width of the slit permits maintenance of a stable concentration distribution with relatively long columns, thus permitting isotopic separation superior to that obtained in the prior art.

0507 Fuels Production And Properties

REFER ALSO TO CITATION(S) 24816

0508 Spent Fuels Reprocessing

REFER ALSO TO CITATION(S) 24624, 25345

24609 **(DP—1736) A totally automatic density meter for radioactive solutions.** Hochel, R.C. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Feb 1987. Contract AC09-76SR00001. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007888.

A totally automatic density meter for measuring the density of radioactive liquid (plutonium nitrate) samples was developed and built for use at the Savannah River Plant. The measurement cell (vibrating U-tube) and other wetted parts are glovebox-contained and are remoted from the electronics and control instrumentation. The only operator actions required are insertion of a sample vial into the system, starting the analysis, and removing the vial about 90 seconds later. The sample measurement takes about 3 to 4 minutes and uses 10 mL of sample; another 5 to 6 minutes is required for a water/air measurement-control check, which leaves the system ready for the next sample. No water bath is needed because a computer algorithm is applied to the measurement to correct it to a standard reference temperature. The system is normally operated under computer control, but a programmable logic controller is available for backup. The system may also be operated manually by means of a switchpanel. 5 refs., 3 figs.

0509 Transport And Storage

REFER ALSO TO CITATION(S) 24632, 24648, 24650, 24651, 24654

24610 **Transportation systems to support the Nuclear Waste Policy Act of 1982.** Wilmot, E.L.; Philpott, R.E. (Office of Civilian Radioactive Waste Management, U.S. Dept. of Energy, Washington, DC 20585). pp 849-858 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Late in 1982, the United States Congress enacted legislation for the disposal of spent nuclear fuel and high-level waste. The policy, embodied in Public Law 97-425 and referred to as the Nuclear Waste Policy Act of 1982 (NWPA), mandates that the Department of Energy (DOE) be responsible for the transport of commercial spent fuel and defense high-level waste from their points of origin to facilities constructed under provisions of the NWPA. It is the purpose of this paper to describe the preliminary transportation policies and plans developed by the Office of Civilian Radioactive Waste Management (OCRWM), within the DOE, to respond to the NWPA mandate.

0510 Marketing, Economics, And By-products

REFER ALSO TO CITATION(S) 24637, 24650, 24651, 24652, 24653, 24654

0520 Waste Management

REFER ALSO TO CITATION(S) 24658, 24660, 24661, 24662, 24663, 24664, 24665, 24666, 24667, 24668, 24669, 25287, 26002, 26003, 26005, 26006, 26019

24611 **(AD-A—175199/9/XAB) Development and field placement of an expansive salt-saturated concrete (ESC) for the Waste Isolation Pilot Plant (WIPP). Final report.** Wakeley, L.D.; Walley, D.M. (Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Structures Lab.). Sep 1986. 51p. (WES/TR/SL—86-36). NTIS, PC A04/MF A01.

An expansive salt-saturated concrete (ESC) was proportioned for placement underground in halite rock at the Waste Isolation Pilot Plant (WIPP) site, near Carlsbad, New Mexico. Requirements for this concrete were: (1) to be chemically compatible with the host rock; (2) to remain pumpable for four hours: (3) to give net volume increase beginning at an early age, and continuing until creep closure of the salt assures sealing at the rock interface; and (4) to cure to a solid with extremely low permeability and fairly high strength. ESC was proportioned and placed underground at the WIPP in two successful field tests during FY 85 and FY 86. This report is the first of three reports about this concrete. It describes (1) the development of ESC in the laboratory, and (2) the mixture properties prior to final set. It summarizes field-placement activities in July 1985 and February 1986, when ESC was placed in test holes underground at the WIPP for two series of Small-Scale Seal Performance Tests (SSSPT). It gives data from tests of expansive behavior of the concrete at early ages and under simulated repository conditions. The second report will describe expansive behavior of ESC relative to several variables that could have an impact on its field performance and long-term stability, as determined during laboratory testing. It also will discuss possible explanations of the rather extraordinary suite of properties exhibited by ESC, as controlled by its chemical composition. The third report will describe laboratory studies of the mechanism of set retardation in a grout derived from this concrete.

24612 **(DOE/CH/10261—T1) [Review comments on the Draft DOE Area Recommendation Report for the Crystalline Repository Project]: Final technical report.** Dutch, S.I.; Stiegliltz, R.D. (Red Cliff Tribal Council, Bayfield, WI (USA)). Mar 1986. Contract FG02-86CH10261. 134p. NTIS MF A01; 2; GPO Dep. File Number DE87007596.

Research performed under the grant primarily involved review and comment on the Draft Area Recommendations Report (DARR). However, because data and "recommendations" included in the DARR are unquestionably tied to years of research and dozens of technical reports and documents, i.e., Screening Methodologies, Regional characterization Reports, etc., it is essential that consultants to the Menominee Tribe review all the relevant DOE documents, working papers, etc. Given the short period provided for technical comment and limited funds available to the Tribe, a well designed and thorough technical review was (and is) without question impossible. What review and comment that did occur on a geotechnical level is included in this report.

24613 **(DOE/CH/10273—1) Review of DOE's proposal for Crystalline bedrock disposal of radioactive waste, north-central area.** Green, J.C. (Fond Du Lac Reservation, Cloquet, MN (USA)). 6 Mar 1986. Contract FG02-86CH10273. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007591.

The DOE's Region-to-Area Screening Methodology for the Crystalline Repository Project (DOE/CH-1), the Final North-Central Region Geologic Characterization Report (DOE/CH-8(1)), and the Draft Area Recommendation Report for the Crystalline Repository Project (DOE/CH-15), with the associated maps, were reviewed. The review has focused on all general information regarding geologic topics and all site-specific data for DOE sites NC-10 and NC-3. This report contains two parts: (1) a point-by-point critique of perceived errors, omissions, or other shortcomings in each of the three documents; and (2) a discussion of the feasibility of crystalline bedrock as a suitable host medium for high-level radioactive waste.

24614 **(DOE/CH/10273—2) Report on draft Area Recommendation Report for the Crystalline Repository Project.** (Fond Du Lac Reservation, Cloquet, MN (USA)). [1987]. Contract FG02-86CH10273. 20p. NTIS, PC A02. File Number DE87007592.

The draft Area Recommendation Report for the Crystalline Repository Project (ARR) is one product which is part and parcel of a process which was established by Congress and implemented by the Department of Energy. Congress, by enacting the Nuclear Waste Policy Act of 1982 (NWPA), Published Law 97-425, 96 stat 2201, 42 USC 10101, directed the Department of Energy to establish a national program which would provide for the development of repositories for the disposal of high-level radioactive waste and spent nuclear fuel, The NWPA requires, among other things, that affected Tribes and States be provided the opportunity to participate fully in the development of proposed repositories. The Fond du Lac Tribe is an affected tribe whose proprietary interests will be impacted by the Crystalline Repository Project as identified in the draft ARR. The draft ARR does not meet the obligations of the NWPA, the Treaties of 1837 and 1842 or the Trust Responsibility to Indian Tribes. The NWPA required participation by affected tribes, of which the Fond du Lac Band of Lake Superior Chippewa is included. This exclusion has placed in question the validity of the initial CRP process and does not adequately protect the interest of the Fond du Lac Band. Further study is required to fully appreciate the total affect that the Fond du Lac Bands interest may have on this report.

24615 **(DOE/CH/10273—3) Critical review of the draft Area Recommendation Report and region-to-area screening methodology for the Crystalline Repository Project.** (EWA, Inc. (USA)). 10 Mar 1986. Contract FG02-86CH10273. 96p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007593.

Two documents related to the Crystalline Repository Project have been reviewed. Comments and concerns related to the review of the "Region-To-Area Screening Methodology" and the

"Draft Area Recommendation Report" are presented. These comments will be considered in preparation of the Final Area Recommendation Report, which will serve to formally identify potentially acceptable sites for a second repository in crystalline rock. Following a detailed review of the aforementioned documents, it is concluded that the identification of proposed potentially acceptable sites in the Draft Area Recommendation Report is based on questionable screening methodology and often incomplete data. As a result, "favorable characteristics" that are ascribed to each of the proposed potentially acceptable sites are, in many cases, misleading.

24616 **(DOE/CH/10273—4) [Fond du Lac archeological resources within the Draft Area Recommendation Report].** Danz, D.L. (Migizi "Eagle" Enterprises, Cloquet, MN (USA)). 28 Jul 1986. Contract FG02-86CH10273. 58p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007594.

Research into archaeological resources of the Fond du Lac Band within the DOE proposed high-level nuclear waste sites resulted in the discovery of four traditional ancestral sites. A number of ancestral sites that are located within other proposed repository sites were also discovered.

24617 **(DOE/NE/44352—T2) Massachusetts' participation in the US Department of Energy's Crystalline Repository Project: Final report.** (Massachusetts Dept. of Public Health, Boston (USA)). Dec 1986. Contract FG02-83NE44352. 183p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87007754.

The purpose of this report is to review activities of the Crystalline Rock Project in Massachusetts, the context in which it arose, and the implications and possibilities of future federal policy decisions on the siting of a high-level waste repository in a crystalline rock body. Although Massachusetts has been eliminated from consideration, there are still issues of concern to be resolved regarding the potential impacts upon Massachusetts if a site were ever to be chosen in New England.

24618 **(DOE/NE/44507—3) Activities of the New York State Geological Survey during participation in the Crystalline Repository Project of the US Department of Energy, 1984-1986: Final report.** Olson, K.E. (New York State Geological Survey, Albany (USA)). Dec 1986. Contract FG02-84NE44507. 144p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87008362.

In 1983, the US Department of Energy (USDOE) selected 235 crystalline rock bodies (CRBs) in the Northeastern, Southeastern and North Central US for evaluation as candidates for the second national radioactive waste repository site. The State of New York was one of these and the candidate crystalline rock bodies were the Adirondack Mountain region and the Hudson Highlands in northern and southern New York State, respectively. From 1984 to 1986, the USDOE, under the Crystalline Repository Project (CRP), funded New York State through the New York State Geological Survey (NYSGS) and the New York State Department of Environmental Conservation (NYSDEC) to review and comment upon the New York (principally Adirondack) section of periodically-issued USDOE documents. To accomplish the most effective evaluation of these documents, the NYSGS established a comprehensive data base concerning all available information published and unpublished on the geology of that part of New York State. The development of a comprehensive geologic data base for the Adirondack Mountain region was the major project undertaken by the NYSGS-CRP towards the evaluation of that region for potential as a radioactive waste disposal site. Activities of the NYSDEC were conducted independently and are not described in this report.

24619 **(DOE/NV/10322—12) NNWSI [Nevada Nuclear Waste Storage Investigations] hole histories: UE-29a No. 1, UE-29a No. 2.** (Fenix and Scisson, Inc., Tulsa, OK (USA); Fenix and Scisson, Inc., Mercury, NV (USA)). Nov 1986. Contract AC08-84NV10322. 26p. NTIS, PC E04/MF A01; 1; GPO Dep. File Number DE87007777.

This report is a compilation of data from two hydrologic exploratory core holes drilled to help identify the area geology and hydrology. The two bore holes were drilled between September, 1981 and January, 1982 under the guidance of the US Geological Survey in Area 29, Nevada Test Site. Data presented in the hole histories include all locations, daily activities, coring records, review of hole conditions, and geophysical log lists, and microfiche copies of the geophysical logs run by the Fenix and Scisson, Inc. subcontractor.

24620 **(DOE/NV/10322—13) NNWSI [Nevada Nuclear Waste Storage Investigations] hole history, UE-25b No. 1.** (Fenix and Scisson, Inc., Tulsa, OK (USA); Fenix and Scisson, Inc., Mercury, NV (USA)). Nov 1986. Contract AC08-84NV10322. 40p. NTIS, PC E06/MF $10.35; 1; GPO Dep. File Number DE87007778.

This report is a compilation of data from UE-25b No. 1 drilled in Area 25 under the guidance of the US Geological Survey. It was drilled to provide geologic and hydrologic information for the Yucca Mountain area. Data presented in this document include the hole history, geophysical log and video tape listings, and microfiche copies of all geophysical logs run in hole by Fenix & Scisson, Inc. subcontractor.

24621 **(EPRI-NP—5077) Updated scaling factors in low-level radwaste: Final report.** Best, W.T.; Miller, A.D. (Impell Corp., Walnut Creek, CA (USA); Advanced Process Technology, Milpitas, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 146p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920343.

This final report, an update of the work reported in NP-4037, describes the work that was done to assist the nuclear industry in complying with the classification requirements listed in 10CFR61, "Licensing Requirements for Land Disposal of Radioactive Waste." This work included collection of new data from all available sources and statistical interpretation of these data. A scaling factor methodology is reported and data for its implementation are presented. Generic scaling factors are proposed for use in determining Ni-63 based on Co-60 by plant type and for determining relative transuranic activities based on Pu-239. In addition, bounding generic scaling factors for boiling water reactors are presented which should be useful for utilities with BWRs when developing and updating site specific scaling factors. The new database in its entirety is presented in appendices to this report.

24622 **(FMPC—2078) Fluidized column biodenitrification demonstration facility at the FMPC [Feed Materials Production Center].** Patton, J.B. (Westinghouse Materials Co. of Ohio, Cincinnati (USA). Feed Materials Production Center). Feb 1987. Contract AC05-86OR21600. 28p. (CONF-870270—1-Summ.). NTIS MF A01; 2; GPO Dep. File Number DE87007311.

From Chemical processing table top seminar; Kingsport, TN, USA (25 Feb 1987).

The mission of the Fernald Ohio Feed Materials Production Center, owned by DOE and operated by Westinghouse Materials Company of Ohio, is to produce uranium metal primarily for fuel in production reactors at Hanford, Washington, and Savannah River, South Carolina. Several waste streams result from production that are combined in the plant general sump and processed through settling basins prior to discharge. Individual streams have varying nitrate concentrations which, when combined, may range up to about 10,000 milligrams/liter. A fluidized-bed technology has been operated to demonstrate nitrate reduction by bacteriological denitrification on production scale. The system consists of two columns operating in series. The demonstration run will be considering: rate of biodenitrification; methyl alcohol consumption (bacterial substrate); sulfuric acid requirement (pH adjustment); accommodation of the biomass by the plant sewage treatment facility; flexibility of the system to receive a waste stream which varies in both volume and nitrate concentration; and modification and/or additions needed in the system to function as a permanent production operation. 8 figs.

24623 **(HEDL-SA—3501-FP) Quality of data used in site selection.** Delvin, W.L. (Hanford Engineering Development Lab., Richland, WA (USA)). 10 Feb 1986. Contract AC06-76FF02170. 6p. (CONF-860654—48). NTIS, PC A02/MF A01; GPO Dep. File Number DE87007701.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

The selection of sites for nuclear waste repositories requires an investigative effort to characterize potential sites with regard to geologic properties and environmental considerations. Such investigations generate scientific and engineering data through the experimental testing and evaluation of geologic and environmental materials and through sampling and analysis of those materials. Data generated for site selection must be correct, defendable, and suitable for their intended use; they must have quality. Five quality characteristics are defined and practices followed by scientists and engineers producing data have been grouped into seven categories called quality guides. These are presented in the paper and the relationship between the guides (practices) and the five quality characteristics is shown.

24624 **(ORNL/TM—10261) Demonstration of the iodine and NO/sub x/ removal systems in the Oak Ridge National Laboratory integrated equipment test facility.** Lewis, B.E.; Jubin, R.T. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007884.

This report summarizes the findings from three sets of experiments on iodine and NO/sub x/ removal performance using dual downdraft condensers in the dissolver off-gas line. The initial experiments were conducted in the laboratory using glassware in proof-of-principle tests. Two additional sets of condenser experiments were conducted using equipment prototyical for a 0.5-t/d plant in the Integrated Equipment Test (IET) facility at the Oak Ridge National Laboratory. This report also describes the NO/sub x/ removal performance of a packed scrubber in the IET during the dissolution of depleted uranium oxides. The overall iodine pass-through efficiency of the condensers in the IET was high as desired. Removal efficiencies ranged from only 0.35 to 6.29%, indicating that the bulk of the iodine in the off-gas will be transferred on through the condensers to the iodox process for final disposal rather than recycled to the dissolver. The optimum operating temperature for the first condenser was in the range of 50 to 70°C, with the temperature of the second condenser held near 20°C. The NO/sub x/ removal performance of the combined dual condensers and packed scrubber resulted in effluent off-gas stream NO/sub x/ compositions of $\sim$0.4 to 1.0%, which are acceptable levels for the iodox process. The NO/sub x/ removal efficiency of the condensers ranged from $\sim$5 to 58%, but was generally around 20%. The removal efficiency of the packed tower scrubber was observed to be in the range of 40 to 60%. The NO/sub x/ removal performance of the condensers tended to complement the performance of the scrubber in that the condenser removal afficiency was high when the scrubber efficiency was low and vice versa.

24625 **(ORNL/TM—10334) ORNL review of TRUEX flowsheet proposed for deployment at the Rockwell Hanford Plutonium Finishing Plant.** Bond, W.D.; Bell, J.T.; Campbell, D.O.; Collins, E.D. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007787.

The Transuranium Extraction (TRUEX) process will be installed at the Rockwell Hanford Operations (RHO) Plutonium Finishing Plant (PFP). The purposes are to process the PFP waste to recover the plutonium, to isolate the americium, and to have the remaining waste converted to a non-TRU waste. Rockwell requested that ORNL provide an outside review of the process and its implementation. This review addresses the generation of the TRUEX feed, the chemical flowsheet, and the products and raffinates. It suggests that present PFP operations be modified to reduce the amount of transuranium elements that will be in the TRUEX process feed. This review also includes an assessment of the TRUEX solvent extraction flowsheet on the bases of material balance, adequate extraction and stripping stages, and solvent cleanup. The final part of the review includes results of three-party discussions [RHO, ORNL, and Argonne National Laboratory (ANL)] of some major issues.

24626 **(PNL—6073) Development of continuous liquid-fed laboratory-scale mini-melter for nuclear waste glass development.** Reimus, M.A.H.; Marschman, S.C.; Graff, G.L. (Pacific Northwest Lab., Richland, WA (USA)). Feb 1987. Contract AC06-76RL01830. 82p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007908.

A small, continuous liquid-fed mini-melter (LFMM) has been developed at Pacific Northwest Laboratory (PNL) to aid in waste glass feed slurry development. The LFMM offers several advantages over testing in large-scale melters. The LFMM requires little lead time in preparing for a test run, and the labor and material requirements are low. Real-time melting behavior of liquid feed slurries can be investigated, and feed rates can be estimated for larger-scale melters. The glass produced is representative of that produced by a larger-scale melter, as well as representative of the processing operation itself. Glass produced by the LFMM may subsequently be analyzed for metallic and other secondary phase formation. In contrast to larger-scale melters, the LFMM may be easily and inexpensively installed in a hot cell because of its relatively small size and simple configuration, enabling testing of radioactive feeds. A total of six LFMM experimental runs were performed. Feeds were obtained which corresponded to PNL melter runs performed in larger PNL developmental joule-heated research melters. These nonradioactive liquid-fed ceramic melters are known as the High-Bay Ceramic Melter (HBCM), the Experimental Ceramic Melter (ECM), and the Pilot-Scale Ceramic Melter (PSCM). Preliminary results obtained with the limited testing are promising. Feeds processed in the LFMM exhibited behavior closely resembling that observed in the large-scale melters. Feed rate correlations between the LFMM and ECM, HBCM, and PSCM were developed to estimate a range of expected feed rates for the large-scale melters from LFMM data. More developmental work with LFMM testing needs to be completed. Further testing will eliminate bias and establish the LFMM's true correlation to, and representation of, large-scale melters.

24627 **(PNL—6174) In situ vitrification of Oak Ridge National Laboratory soil and limestone.** Carter, J.G.; Bates, S.O.; Maupin, G.D. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1987. Contract AC06-76RL01830. 48p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007894.

Process feasibility studies were successfully performed on two different developmental scales to determine the technical application of in situ vitrification (ISV) to Oak Ridge National Laboratory (ORNL) intermediate-level waste. In the laboratory, testing was performed on crucibles containing quantities of 50% ORNL soil and 50% ORNL limestone. In the engineering-scale testing, a 1/12-scaled simulation of ORNL Trench 7 was constructed and vitrified, resulting in waste product soil and limestone concentrations of 68% and 32%, respectively. Results from the two scales of testing indicate that the ORNL intermediate-level waste sites may be successfully processed by ISV; the waste form will retain significant quantities of the cesium and strontium. Because ^{137}Cs is the major component of the radionuclide inventory in the ORNL seepage pits and trenches, final field process decontamination factors (i.e., off gas at the ground surface relative to the waste inventory) of 10^4 are desired to minimize activity buildup in the off-gas system. These values were realized during the engineering-scale test for both cesium and strontium. The vitrified material effectively contained 99.996% of the cesium and strontium placed in the engineering-scale test. This is equivalent to decontamination factors of greater than 10^4. Volume reduction for the engineering-scale test was 60%. No migration of the cesium to the uncontaminated surrounding soil was detected. These favorable results indicate that, once verified in a pilot-scale test, an adequately designed ISV system could be produced to treat the ORNL seepage pits and trenches without excessive activity accumulation in the off-gas treatment system.

24628 **(PNL/SRP—6146) Data report on gamma radiolysis tests on PBB1 and PBB3 brines: Salt Repository Project.** Gray, W.J. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1987. Contract AC06-76RL01830. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007842.

The tests described in this data report are described in the FY 1986 Technical Program Plan (TPP), WBS Element 0302 - Brine Radiolysis, for the Waste Package Program at Pacific Northwest Laboratory (PNL), conducted for the Salt Repository Project through the Office of Civilian Radioactive Waste Management (OCRWM), Department of Energy. Two types of tests were outlined in the FY 1986 TPP, one in which PBB1 and PBB3 brines were to be irradiated in closed systems while the buildup of gas pressure was monitored, and the second in which the Eh of PBB1 and PBB3 brines was to be monitored continuously during irradiation. The first type of test was intended to simulate repository conditions by including coupons of mild steel to represent container material. Blank tests, which involved either no radiation or no steel coupons, were added to both of the test matrices to aid in understanding the radiolysis results. Hindsight shows that the tests that included steel coupons provided corrosion-relevant data but generated little useful radiolysis information. The second type of test was intended to use platinum electrodes to measure the effect of radiolysis on the redox potential of the brines. Eh measurements were to be made during irradiation because it was thought that the redox potential might change rapidly after the irradiation was terminated. If that were true, then Eh measurements made only after irradiation would be misleading. However, platinum electrodes were found to be ill-suited for measuring the redox potential of PBB1 and PBB3 brines; therefore, a different method is needed. Some exploratory testing is being conducted, and results obtained to date are reported here along with the more extensive gas pressure and corrosion results. This data report will be followed at a later date by a summary or topical report, which will include analysis of the data. The data in this data report are preliminary; they have been neither analyzed nor evaluated.

24629 (SAND—86-2024C) Overview of waste package performance experiments in WIPP [Waste Isolation Pilot Plant]. Molecke, M.A. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 4p. (CONF-860418—24). NTIS, PC A02. File Number DE87007083.

From 88. annual meeting of the American Ceramic Society; Chicago, IL, USA (27 Apr 1986).

Several series of nuclear waste package performance experiments are being conducted in situ at the Waste Isolation Pilot Plant (WIPP) facility, near Carlsbad, New Mexico. These nonradioactive experiments are (or are currently in the process of being) emplaced in bedded rocksalt, in several underground test rooms of the WIPP, approximately 650 m below the surface. These tests are being performed by Sandia National Laboratories (with significant participation by Savannah River Laboratory, and others), for the US Department of Energy. Two of these WIPP experiments involve the in situ leaching and interaction testing of simulated (i.e., nonradioactive) high-level waste glasses from several US and international waste form producers: these are the Simulated Defense High-Level Waste (DHLW) Technology Experiments and the WIPP Materials Interface Interactions Test (MIIT). Another test series is the Simulated Contact-Handled and Remote-Handled Transuranic Waste (CH and RH TRU) Technology Experiments. It is the purpose of this paper to provide an overview of: the various test and waste package design details, the experimental objectives, and the status of each test series. The primary focus of this paper will be on the tests containing glass waste forms.

24630 (SAND—86-2673) Compilation of selected deep-sea biological data for the US subseabed disposal project. Gomez, L.S.; Marietta, M.G.; Jackson, D.W. (Sandia National Labs., Albuquerque, NM (USA); Scientific Information Management, Inc., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 70p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007950.

The US Subseabed Disposal Project (SDP) has compiled an extensive deep-sea biological data base to be used in calculating biological parameters of state and rate included in mathematical models of oceanographic transport of radionuclides. The data base is organized around a model deep-sea ecosystem which includes the following components: zooplankton, fish and other nekton, invertebrate benthic megafauna, benthic macrofauna, benthic meiofauna, heterotrophic microbiota, as well as suspended and sediment particulate organic carbon. Measurements of abundance and activity rates (e.g., respiration, production, sedimentation, etc.) reported in the international oceanographic literature are summarized in 23 tables. Included in these tables are the latitudinal position of the studies, as well as information describing sampling techniques and any special notes needed to better assess the data presented. This report has been prepared primarily as a resource document to be used in calculating parameter values for various modeling applications, and for preparing historical data reviews for other SDP reports. Depending on the intended use, these data will require further reduction and unit conversion.

24631 (USGS-OFR—86-369) Report on televiewer log and stress measurements in holes USW G-3 and Ue-25p1, Yucca Mountain, Nye County, Nevada. Stock, J.M.; Healy, J.H.; Svitek, J.; Mastin, L. (Geological Survey, Menlo Park, CA (USA)). 1986. Contract AI08-78ET44802. 96p. NTIS MF A01; 2; GPO Dep. File Number DE87007537.

Hydraulic fracturing stress measurements and televiewer observations were made in drill holes USW G-3 and Ue-25p1 on Yucca Mountain, Nevada, as part of a continuing investigation of the tectonic stress field in the vicinity of a proposed site for the disposal of nuclear waste. The results from USW G-3 are similar to the results reported previously from USW G-1 and USW G-2 with a low least horizontal principal stress in a direction approximately N65°W. This indicates a normal faulting stress regime consistent with the inferred regional extension in this part of the Basin and Range province. The number of reliable hydraulic fracturing tests in Ue-25p1 is not sufficient to reliably characterize the state of stress at this site, but some definite conclusions can be drawn from these data. The pressure curves observed during many of the frac tests are significantly different from the curves observed in USW G-1, USW G-2, and USW G-3. The breakdown pressures are higher, suggesting a higher least horizontal principal stress and/or a substantially higher apparent tensile strength for the rocks in this hole. The instantaneous shut-in pressure does not clearly reveal the least horizontal principal stress in most of the frac tests, but two pressure versus volume pumping tests in the Paleozoic rocks show a fracture opening pressure close to the vertical stress, suggesting that the least horizontal principal stress could possibly be as high as the vertical stress. One good hydraulic fracturing test reveals a least horizontal stress much less than the vertical stress, with a greatest horizontal principal stress close to but less than the vertical stress. No drilling-induced hydraulic fractures were observed in this hole, in contrast to the three USW G holes which had drilling-induced hydrulic fractures in the upper portions of the televiewer logs.

24632 Evaluation of titanium alloy resistance upset welds for waste canisters. Knorovsky, G.A.; Headley, T.J. (Sandia National Labs.). pp 40-41 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Isolation of highly radioactive defense wastes from the biosphere is a subject under intense investigation by a number of national laboratories. One proposed method involves densification of wastes into a glassy solid, followed by long-term storage deep underground in bedded salt strata. Since the vitrification facility and the waste repository are not located adjacent to one another, a container is needed to assure isolation during transport from one to the other. Additionally, it is desirable that the canister act as a mold for the molten glass and, further, that it provide an additional barrier to waste migration while in the repository. A primary candidate for these canisters is ASTM B 265 Grade 12 titanium alloy. This alloy, which contains nominally 0.8% Ni and 0.3% Mo, has been found to be extremely corrosion resistant to brine environments. This latter feature is important because of the possibility of brine intrusions at any bedded salt repository. Other desirable features of this alloy include its good fabricability, mechanical properties, fusion weldability, and competitive cost when compared with other possible materials. Extensive metallurgical studies have been conduced on this alloy in order to understand its corrosion behavior under repository conditions. Cylindrical canisters approximately 0.6 m (23.6 in.) diameter by 3.0 m (9.8 ft) tall are proposed. The wall thickness is 6.4 mm (1/4 in.), with a 19 mm (3/4 in.) thick top reinforcement, also incorporating a handling pintle and provision for a resistance upset closure weld. The closure weld will be a 13 mm (0.51 in.) thick by 130 mm (5.1 in.) diameter disk forced into a 2 mm (0.08 in.) smaller diameter bore. Resistance upset welding, a solid state welding procedure, was chosen for these closure welds because of its simplicity, reliability, and ability to be carried out remotely.

24633 **Advanced fiber optical chemical sensing networks.** Hirschfeld, T.B. (Lawrence Livermore National Lab., P.O. Box 808, Livermore, CA 94550). pp 390 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

Many industrial processes or other phenomena of interest cannot be measured with conventional instruments because they are too hot, too cold, highly radioactive, or otherwise inaccessible to direct observation. Nuclear wastes stored in underground repositories, for example, will require in-situ monitoring. A new technology that uses long-distance fiber optics to transmit laser-excited fluorescence now makes it possible to remotely monitor such phenomena via optical cables at distances up to a kilometer. The basic system consists of a laser light source, a Raman-fluorescence scattering spectrometer, and an optical fiber linked to a measuring device at the other end. Laser-generated light passes through an aperture and is focused on the end of the optical fiber by a geometric beam splitter. The light passes through the fiber, interacts with the sample to be measured, and returns (now incoherent), where it is reflected by a mirror into the computerized spectrometer for analysis.

24634 **An automated sensitivity analysis procedure for the performance assessment of nuclear waste isolation systems.** Pin, F.G.; Worley, B.A.; Oblow, E.M.; Wright, R.Q.; Harper, W.V. (Oak Ridge National Lab., Oak Ridge, TN 37831). *Nuclear and Chemical Waste Management;* **6**: No. 3/4, 255-263(1986). Contract AC05-84OR21400.

To support an effort in making large-scale sensitivity analyses feasible, cost efficient and quantitatively complete, the authors have developed an automated procedure making use of computer calculus. The procedure, called GRESS (GRadient Enhanced Software System), is embodied in a precompiler that can process Fortran computer codes and add derivative-taking capabilities to the normal calculation scheme. In this paper, the automated GRESS procedure is described and applied to the code UCB-NE-10.2, which simulates the migration through a sorption medium of the radionuclide members of a decay chain. The sensitivity calculations for a sample problem are verified using comparison with analytical and perturbation analysis results. Conclusions are drawn relative to the applicability of GRESS for more general large-scale sensitivity studies, and the role of such techniques in an overall sensitivity and uncertainty analysis program is discussed.

24635 **Precipitation process for the removal of technetium values from nuclear waste solutions.** Walker, D.D.; Ebra, M.A. (to Dept. of Energy). US Patent Application 6-800,588. 21 Nov 1985. 17p. Contract AC09-76SR00001. DE87007277 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007277.

High efficiency removal of techetium values from a nuclear waste stream is achieved by addition to the waste stream of a precipitant contributing tetraphenylphosphonium cation, such that a substantial portion of the technetium values are precipitated as an insoluble pertechnetate salt.

24636 **Behavior of carbon-14 in waste packages for spent fuel in a repository in tuff.** Van Konynenburg, R.A.; Smith, C.F.; Culham, H.W.; Otto, C.H. Jr. (Lawrence Livermore National Lab., CA). *Materials Research Society Symposia Proceedings;* **44**: 405-412(1985). Contract W-7405-ENG-48.

Analysis of gas from a heated air-filled canister containing a spent fuel assembly before and after rupture of a fuel rod shows that about 1.5 mCi of ^{14}C from the external surface of the assembly was rapidly oxidized and released as ^{14}CO$_2$ in excess oxygen at 275°C and 10^4 /sup rad//hr. After rupture, an additional 0.3 mCi was released, probably also from the external surface. The total ^{14}C inventory in the entire 15 x 15 rod assembly including structural hardware is estimated to be 690 mCi. These measurements indicate that account will have to be taken of the time distribution of lifetimes of the canisters, and a broad definition of the engineered system may be necessary, in order to meet 10CFR60 requirements with spent fuel in a repository in tuff. 22 references, 1 table.

24637 **Life-cycle costs for the civilian radioactive waste management program.** Milner, R.; Haines, F.; Bornstein, G.; Leiter, A. (Office of Civilian Radioactive Waste Management, U.S. Dept. of Energy, Washington, DC 20585). pp 789-802 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The total system life-cycle cost (TSLCC) analysis for the Department of Energy's (DOE) Civilian Radioactive Waste Management Program is an ongoing activity that helps determine whether the revenue-producing mechanism established by the Nuclear Waste Policy Act of 1982--a fee levied on the producers of nuclear power--is sufficient to cover the cost of the program. This paper summarizes the program cost estimates in the third fee adequacy evaluation conducted in January 1985. Costs for reference waste-management program were estimated to be 24 to 30 billion (1984) dollars. Costs for the sensitivity cases studied ranged from 21 to 35 billion dollars. Factors such as repository location, quantity of waste generated, transportation cask technology, and repository startup dates were shown to exert substantial impacts on total-system costs.

24638 **Development of high temperature and pressure zirconia-based pH sensors.** Danielson, M.J.; Koski, O.H.; Myers, J. (Pacific Northwest Lab., P.O. Box 999, Richland, WA 99352). pp 597-606 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Yttria-stabilized zirconia pH sensors are suitable for use from 100-300°C. A new Pt internal half cell is discussed which results in a considerable simplification in their calibration. A degradation process takes place after prolonged exposure to 300°C conditions and is manifested by a loss of full Nerstian response at temperature $\leqq$ 200°C. A hypothesis for the degradation process is discussed.

24639 **Status of the United States' high-level nuclear waste disposal program.** Rusche, B. (Office of Civilian Radioactive Waste Management, U.S. Dept. of Energy, Washington, DC 20585). pp 101-116 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The Nuclear Waste Policy Act of 1982 is a remarkable piece of legislation in that there is general agreement on its key provisions. Nevertheless, this is a program intended to span more than a century, with some choices by Congress, states, Indian tribes and the nuclear power industry yet to be made. The crafters of the Act clearly recognized this. And further, the crafters recognized ". . .that. . .state, Indian tribe and public participation in the planning and development of repositories is essential in order to promote public confidence in the safety of disposal of such waste and spent fuel . . . High-level radioactive waste and spent nuclear fuel have become major subjects of public concern, and appropriate precautions must be taken to ensure that such waste and spent fuel do not adversely affect the public health and safety and the environment for this or future generations.

24640 DOE perspectives on institutional interactions. Gale, B.G.; Squires, D.J. (Siting Div., Office of Geologic Repositories, Office of Civilian Radioactive Waste Management, U.S. Dept. of Energy, Washington, DC 20585). pp 117-124 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Many interactions by the BWIP have been performed during the life of the project, with the organizations identified in this paper. These interactions have taken the form of reviews of documents and reports by the public, state and Federal agencies, affected Indian tribes, and many others. They have also included meetings, briefings, hearings, and tours of BWIP facilities by these groups and organizations. The objective of BWIP is to conduct an open information program and make available all data to those who wish to see it. The extensive information process presently taking place is a major step in implementing the requirements of the NWPA for involvement by Federal agencies, states, affected Indian tribes, and the public. These actions will continue through the life of the project to allow for full participation in the Nation's repository selection process.

24641 Two-phase repository concept. Marron, J.F. (Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352). pp 449-460 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The two-phase repository development is a viable concept to enable limited, early waste emplacement at the Hanford Site and full-scale waste emplacement five years later. This is a primary conclusion of a feasibility study undertaken in 1984 to verify the validity of the two-phase repository development concept. This paper presents a summary of the concepts and conclusions from the study.

24642 The WIPP research and development test program. Tyler, L.D. (Experimental Programs Div., Sandia National Labs., Albuquerque, NM 87185). pp 471-476 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—). Contract AC04-76DP00789.

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The WIPP (Waste Isolation Pilot Plant) is a DOE R&D Facility for the purpose of developing the technology needed for the safe disposal of the United States defense-related radioactive waste. The in-situ test program is defined for the thermal-structural interactions, plugging and sealing, and waste package interactions in a salt environment. An integrated series of large-scale underground tests address the issues of both systems and long-term isolation performance of a repository.

24643 The reference waste package design for a nuclear waste repository in basalt. Mc Call, T.B.; Krogness, J.C. (Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352). pp 525-532 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

This paper describes the reference waste package design for the Basalt Waste Isolation Project (BWIP). The waste form, functional requirements, and engineering approach for the reference design are described. A short horizontal borehole emplacement configuration (SHB) containing a single waste package can meet the functional requirements during the operating, containment, and post-containment periods. The waste form will be placed in a thick-walled, low-carbon steel container. Surrounding the container is packing material made from a mixture of crushed basalt and sodium bentonite clay.

24644 General corrosion studies of candidate container materials for the Basalt Waste Isolation Project. Lutton, J.M.; Brehm, W.F.; Maffei, H.P.; Rivera, C.L.; Anantatmula, R.P. (Westinghouse Hanford Co., P.O. Box 1970, Richland, WA 99352). pp 563-572 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The general corrosion studies program consists of three types of tests to determine the corrosion behavior of candidate container materials for the Basalt Waste Repository. Air/steam tests simulate conditions in the repository operating period, and static and refreshed pressure vessel tests simulate post-closure conditions. Copper and iron-based alloys and their weldments are being tested. Weight loss and surface analysis data from two short-term tests are reported. In these, the effect of weldments in static groundwater, and that of packing material in an air/steam environment were studied. Early results from long-term testing are also included.

24645 WIPP waste package performance testing on simulated DHLW: Early data. Molecke, M.A. (Sandia National Labs., Div. 6332, Albuquerque, NM 87185). pp 573-584 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—). Contract AC04-76DP00789.

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Several series of waste performance experiments are currently being conducted at the Waste Isolation Pilot Plant (WIPP) facility. These experiments involve 18 full-size, simulated (nonradioactive) defense high-level waste (DHLW) containers of several waste package designs. These DHLW packages are emplaced in vertical boreholes in bedded rock salt, under both (thermal) near-reference and accelerated-aging repository conditions. A major purpose of these experiments is to evaluate the in-situ materials performance (i.e., degradation and alteration) of the various waste package barriers: metallic waste canisters and overpacks, backfill materials, and high-level glass waste form (nonradioactive). This paper describes the current technical status of these WIPP tests and discusses the available, early results.

24646 Effects of sorption hysteresis on radionuclide releases from waste packages. Barney, G.S.; Reed, D.T. (Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352). pp 701-712 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

A one-dimensional, numerical transport model was used to calculate radionuclide releases from waste packages emplaced in a nuclear waste repository in basalt. The model incorporates both sorption and desorption isotherm parameters measured previously for sorption of key radionuclides on the packing material component of the waste package. Sorption hysteresis as described by these isotherms lowered releases of some radionuclides by as much as two orders of magnitude. Radionuclides that have low molar inventories (relative to uranium), high solubility, and strongly sorbed, are most affected by sorption hysteresis. In these cases, almost the entire radionuclide inventory is sorbed on the packing material. The model can be used to help optimize the thickness of the packing material layer by comparing release rate versus packing material thickness curves with Nuclear Regulatory Commission (NRC) and Environmental Protection Agency (EPA) release limits.

24647 Automated sensitivity analysis of the radionuclide migration code UCB-NE-10.2. Pin, F.G.; Worley, B.A.; Oblow, E.M.; Wright, R.Q.; Harper, W.V. (Oak Ridge National Lab., P.O. Box X, Oak Ridge, TN 37831). pp 713-726 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The Salt Repository Project (SRP) of the U.S. Department of Energy is performing ongoing performance assessment analyses for the eventual licensing of an underground high-level nuclear waste repository in salt. As part of these studies, sensitivity and uncertainty analyses play a major role in the identification of important parameters, and in the identification of specific data needs for site characterization. Oak Ridge National Laboratory has supported the SRP in this effort resulting in thee development of an automated procedure for performing large scale sensitivity analysis using computer calculus. GRESS, GRadient Enhanced Software System, is a pre-compiler that can process FORTRAN computer codes and add derivative taking capabilities to the normal calculated results. The GRESS code is described and applied to the code UCB-NE-10.2 which simulates the migration through a sorption medium of the radionuclide members of a decay chain.

24648 Basalt Waste Isolation Project preclosure performance assessment: Methods and objectives. Franklin, A.L. (Pacific Northwest Lab., P.O. Box 999, Richland, WA 99352). pp 739-748 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

A subsurface nuclear waste repository in basalt (NWRB) is being considered at the Hanford site in Richland, Washington. Based on a conceptual design of the NWRB, the facility would accept commercial high level waste (CHLW), spent fuel (SF), and low level transuranic wastes (LL-TRUW) for a period of twenty years. Each canister will be configured for disposal, emplaced in a placement hole and monitored for a period of 50 years in a state of potential retrievability. When the monitoring period is complete, backfill will be placed in the annulus around the waste canister and the surface facilities will be decommissioned.

24649 Mathematical modeling of waste repository performance: A peer review. Lieberman, J.A.; Lee, W.W.L. (OTHA, Inc., P.O. Box 686, Glen Echo, MD 20872). pp 749-758 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

This paper describes the rationale, membership, operation and major observations of the Performance Assessment National Review Group. The Group was assembled by Weston at the request of the U.S. Department of Energy Office of Civilian Radioactive Waste Management to review performance assessment work in the U.S. basalt, salt and tuff repository projects. The purposes were to evaluate the adequacy of the current methods, identify deficiencies, and suggest potential improvements on repository performance assessment.

24650 Current estimates of MRS system costs. Izatt, R.D. (U.S. Dept. of Energy, Richland Operations Office, Richland, WA 99352). pp 759-768 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

In order to understand monitored retrievable storage (MRS) system costs, it is necessary to understand what MRS is, why the DOE is evaluating it, what the evaluation status is and how the Federal waste management system with MRS would function. This necessary background is presented first followed by details on the costs. The Nuclear Waste Policy Act of 1982 (NWPA) tasked the U.S. Department of Energy to prepare a proposal for construction of a monitored retrievable storage facility for commercial spent fuel and high-level waste and to submit it to Congress for consideration. The NWPA was, however, very specific in stating that "...disposal of high-level radioactive waste and spent nuclear fuel in a repository developed under this NWPA should proceed regardless of any construction of a monitored retrievable storage facility..." Specifically with regard to MRS, the NWPA directs the DOE to "...complete a detailed study of the need for and feasibility of, and ...submit to the Congress a proposal for, the construction of one or more monitored retrievable storage facilities for high-level radioactive waste and spent nuclear fuel."

24651 Design, cost, schedule and licensing implications of an integrated waste management system. Conner, C.W.; Wilmot, E.L. (Office of Civilian Radioactive Waste Management, U.S. Dept. of Energy, Washington, DC 20585). pp 769-788 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

This paper reports on a study that has produced data needed for the MRS Needs and Feasibility Report currently in preparation for submittal to Congress. The facility designs are now compatible in terms of functions, operations, technology and costs. The cost estimates are also compatible being based upon compatible designs, operating procedures and unit costs. The licensing and schedule impacts are systematically examined. This study does not provide all data needed to answer all systems questions, nor was it intended to do so. It will, however, enhance the Needs and Feasibility Report and enhance the integration of the waste management system.

24652 Effects of waste content of glass waste forms on Savannah River high-level waste disposal costs. Mc Donnell, W.R.; Jantzen, C.M. (E.I. du Pont de Nemours and Co., Inc., Savannah River Lab., Aiken, SC 29808). pp 803-814 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—). Contract AC09-76SR00001.

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Effects of the waste content of glass waste forms on Savannah River high-level waste disposal costs are evaluated by their impact on the number of waste canisters produced. Changes in waste content affect onsite Defense Waste Processing Facility (DWPF) costs as well as offsite shipping and repository emplacement charges. A nominal 1% increase over the 28 wt% waste loading of DWPF glass would reduce disposal costs by about $50 million for Savannah River wastes generated to the year 2000. Waste form modifications under current study include adjustments of glass frit content to compensate for added salt decontamination residues and increased sludge loadings in the DWPF glass. Projected cost reductions demonstrate significant incentives for continued optimization of the glass waste loadings.

24653 Economic considerations/comparisons for the disposal of defense high-level waste. Leclaire, D.B.; Lazur, E.G. (Office of Defense Waste and By-Products Management, U.S. Dept. of Energy, Washington, DC 20545). pp 815-818 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

This paper provides a summary, in a generic sense, of the economic considerations and comparisons of permanent isolation of defense high-level waste (DHLW) in a licensed geologic repository. Topics considered include underground disposal, economic analysis, comparative evaluations, national defense, radioactive waste facilities, and licensing.

24654 **Monitored retrievable storage status.** Carlson, J.H. (Office of Civilian Radioactive Waste Management, U.S. Dept. of Energy, Washington, DC 20585). pp 859-866 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The Department of Energy (DOE) is preparing a proposal for Congressional consideration of the inclusion of a monitored retrievable storage (MRS) facility as part of the Federal Nuclear Waste Management System. The DOE plans to submit the proposal package to the Congress by January 15, 1986. The proposed preferred location of the MRS facility is the former Clinch River Breeder site in the state of Tennessee. If the Congress approves implementation of the MRS proposal, it is estimated that the facility could be licensed and operational in ten years.

24655 **Subseabed disposal: A potential alternative to mined repositories.** Bertram, S.G.; Anderson, D.R. (Seabed Programs Div., Sandia National Labs., P.O. Box 5800, Albuquerque, NM 87185). pp 877-886 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The Subseabed Disposal Project at Sandia National Laboratories is investigating the disposal of high-level radioactive waste and spent fuel in the deep ocean floor. The project is closely integrated with international studies of subseabed disposal. The research program focuses on assessments in six major fields of study: site, barrier, environment, engineering, safety, and institutions. The international program will publish a Concept Assessment Report in 1987, presenting the research results available at that time. Subsequent publication of scientific, environmental and preliminary engineering results obtained in the various national programs is planned for about 1990.

24656 **Reply.** Dienes, J.K. (Los Alamos National Lab., NM). *Journal of Geophysical Research;* **89**: No. B4, 2508(10 Apr 1984).

The factor of 3 appearing in the stability criterion given by Dienes [1983] did indeed seem puzzling, and the author is most grateful to Rice [this issue] for pointing out that when traction on the crack boundary is accounted for in the energy balance, the stability criterion involves simply the square of the stress difference, $(\sigma$ - tau$)^2$, rather than $(\sigma$ - tau$)(\sigma$ - 3tau). His analysis of the shear crack problem using the uniformly stressed state as a reference rather than the unstressed state leads to an elegant alternative to his original stability analysis. The material of Appendix A was included in order to show that the strain energy has the form A $(\sigma$ - tau$)^2$, an assumption that a reviewer did not consider obvious. The author is indebted to Rice [this issue] for pointing out that an expression for strain energy involving integration only over the crack surface was previously obtained by Rice and Drucker [1967], and they point out that this significantly simplifies the calculation of strain energy. However, neither their paper nor that of Murrell [1964], which also contains that result, discusses the problem of a crack with finite traction acting on its surface, to which (A8) applies. As pointed out in my paper, it follows from (A8) that the strain energy does not in general have the simple stress dependence of $(\sigma$ - tau$)^2$, this form being valid only for simple closed cracks.

24657 **(DOE-tr—7007921) Alternative waste management techniques for spent nuclear fuel: Final report: Continuation of long-term leaching tests at 200°C and investigation of the influence of iron on leaching.** Ellinger, M.; Wuertz, R. (Battelle Memorial Inst., Columbus, OH (USA); Kraftwerk Union A.G., Erlangen (Germany, F.R.)). [1987]. Contract W-7405-ENG-92. Translation of R 917/85/104, August 1985. (BMFT-KWA—5124/A7). 84p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007921.

In connection with long-term leach tests already completed, which lasted over a year, the same fuel specimens were leached for an additional year by a rock-salt (sodium chloride) solution and by a quinary brine. At the same time leaching was traced using similar fresh fuel specimens in the presence of the repository cask material GGG 40.3. The leach rates determined in the second year of testing in quinary brine confirm the results of the first test year for all nuclides investigated. In sodium chloride solution, on the other hand, an acceleration of leaching during the second year of testing was found with some nuclides. The reason for this is a change in the fragmented fuel specimen caused by the effect of atmospheric oxygen during storage between the two test years. In the presence of iron the leach rates of all nuclides investigated are reduced by a factor of from five to ten. The dissolved fraction of fission products is much smaller in concentrated salt solutions than in the diluted solutions that were investigated during the first year of testing. The more realistic tests in the presence of iron affect the source term model and result in a much reduced mobilization of radionuclides.

0530 Environmental Aspects

REFER ALSO TO CITATION(S) 24634

24658 **(LBL—21639) Simulation of uranium transport with variable temperature and oxidation potential: The computer program THCC [Thermo-Hydro-Chemical Coupling].** Carnahan, C.L. (Lawrence Berkeley Lab., CA (USA)). Dec 1986. Contract AC03-76SF00098. 12p. (CONF-861207—92). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007178.

From Materials Research Society fall meeting; Boston, MA, USA (1 Dec 1986).

A simulator of reactive chemical transport has been constructed with the capabilities of treating variable temperatures and variable oxidation potentials within a single simulation. Homogeneous and heterogeneous chemical reactions are simulated at temperature-dependent equilibrium, and changes of oxidation states of multivalent elements can be simulated during transport. Chemical mass action relations for formation of complexes in the fluid phase are included explicitly within the partial differential equations of transport, and a special algorithm greatly simplifies treatment of reversible precipitation of solid phases. This approach allows direct solution of the complete set of governing equations for concentrations of all aqueous species and solids affected simultaneously by chemical and physical processes. Results of example simulations of transport, along a temperature gradient, of uranium solution species under conditions of varying pH and oxidation potential and with reversible precipitation of uraninite and coffinite are presented. The examples illustrate how inclusion of variable temperature and oxidation potential in numerical simulators can enhance understanding of the chemical mechanisms affecting migration of multivalent waste elements.

24659 **Radionuclide export by deer mice at a solid radioactive waste disposal area in southeastern Idaho.** Arthur, W.J.; Markham, O.D.; Groves, C.R.; Keller, B.L. (Idaho National Engineering Lab., Idaho Falls). *Health Physics;* No. 1, 45-53(Jan 1987).

Concentrations of 90Sr, 137Cs, 238Pu, 239+240Pu, and 241Am in deer mice tissues collected from a radioactive waste disposal area in southeastern Idaho were significantly (p less than 0.05) higher than those from a control area. The highest concentrations of Pu and Am occurred in pelts of deer mice inhabiting an area which had elevated surface and subsurface soil concentrations of these nuclides as compared to other Subsurface Disposal Area locations. Therefore, transuranic contamination in tissues likely originated from both soil depths. However, 137Cs and 90Sr in tissues likely originated from subsurface areas, since surface soils were below background concentrations for these nuclides. Based on a minimum of 6160 deer mice inhabiting the 36-ha waste disposal area over a 1-yr period, a total minimum inventory of 22.8 mu Ci radioactivity was contained in deer mice tissues. Of this estimate, 22.7 mu Ci activity was due to the radionuclides 90Sr and 137Cs. An estimated total of 8.4 mu Ci was transported from the disposal area in mice dispersing from the area. A calculated annual radionuclide inventory of 28.8 mu Ci in deer mice feces was deposited in and around the radioactive waste disposal area. Deer mice inhabiting the SDA are a mode of radionuclide uptake and transport; however, the environmental consequences of this transport mechanism are likely minimal. The results for deer mice, which make up 69% of the small mammal biomass, are discussed in relation to other small mammals within the disposal area. Other modes of transport associated with the deer mice, such as radionuclides in excavated soils associated with burrowing activities and predation, are also discussed.

24660 **Reliable predictions of waste performance in a geologic repository.** Pigford, T.H.; Chambre, P.L. (Dept. of Nuclear Engineering and Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 163-186 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—). Contract AC03-76SF00098.

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Establishing reliable estimates of long-term performance of a waste repository requires emphasis upon valid theories to predict performance. Predicting rates that radionuclides are released from waste packages cannot rest upon empirical extrapolations of laboratory leach data. Reliable predictions can be based on simple bounding theoretical models, such as solubility-limited bulk-flow, if the assumed parameters are reliably known or defensibly conservative. Wherever possible, performance analysis should proceed beyond simple bounding calculations to obtain a more realistic--and usually more favorable--estimates of expected performance. Desire for greater realism must be balanced again increasing uncertainties in prediction and loss of reliability. Theoretical predictions of release rate based on mass-transfer analysis are bounding and the theory can be verified. Postulated repository analogues to simulate laboratory leach experiments introduce arbitrary and fictitious repository parameters and are shown not to agree with well-established theory.

24661 **Hydrological evaluation of five sedimentary rocks for high-level waste disposal.** Lomenick, T.F.; Kanehiro, B.Y. (Chemical Technology Div., Oak Ridge National Lab., P.O. Box X, Oak Ridge, TN 37831). pp 247-255 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—). Contract AC05-84OR21400.

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Utilizing performance criteria that are based upon siting guidelines issued by DOE for postclosure as well as preclosure conditions, a preliminary hydrologic evaluation and ranking is being conducted to determine the suitability of five sedimentary rocks as potential host rocks for a high-level radioactive waste repository. Based upon both quantitative and qualitative considerations, the hydrological ranking of the rocks in order of their potential as a host rock for the disposal of radioactive wastes would be shale, anhydrock, sandstone, chalk, and carbonates, with the first three rocks being significantly better than the remaining two types.

24662 **Hydrologic test plans for large-scale, multiple-well tests in support of site characterization at Hanford, Washington.** Rogers, P.M.; Stone, R.; Lu, A.H. (Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352). pp 325-336 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The Basalt Waste Isolation Project is preparing plans for tests and has begun work on some tests that will provide the data necessary for the hydrogeologic characterization of a site located on a United States government reservation at Hanford, Washington. This site is being considered for the Nation's first geologic repository of high level nuclear waste. Hydrogeologic characterization of this site requires several lines of investigation which include: surface-based small-scale tests, testing performed at depth from an exploratory shaft, geochemistry investigations, regional studies, and site-specific investigations using large-scale, multiple-well hydraulic tests. The large-scale multiple-well tests are planned for several locations in and around the site. These tests are being designed to provide estimates of hydraulic parameter values of the geologic media, chemical properties of the groundwater, and hydrogeologic boundary conditions at a scale appropriate for evaluating repository performance with respect to potential radionuclide transport.

24663 **Experimental approaches to determining the extent of equilibrium in a basaltic hydrothermal system.** Allen, C.C.; Kasper, R.B.; Lane, D.L.; Johnston, R.G.; Rawson, S.A. (Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352). pp 371-380 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Experiments in a basaltic hydrothermal system were conducted at 300°C to assess the extent to which equilibrium can be approached on a laboratory time scale. In these tests, the primary reacting phase in the basalt was mesostasis glass. In closed systems a metastable suite of secondary minerals was formed, which included cristobaite, smectite clay, and high silica/alumina zeolites. In open-system experiments, the secondary minerals more closely approximated natural high-temperature assemblages than did those from the closed-system tests. These experiments provide input to source term and modeling calculations of the geochemical behavior of a nuclear waste repository in basalt.

24664 **/sup 36/Cl measurements of the unsaturated zone flux at Yucca Mountain.** Norris, A.E.; Wolfsberg, K.; Gifford, S.K. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM 87545). pp 381-388 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Determining the unsaturated zone percolation rate, or flux, is an extremely important site characterization issue for the proposed Yucca Mountain nuclear waste repository. A new technique that measures the /sup 36/Cl content of tuff from the Exploratory Shaft will be used to calculate flux through the unsaturated zone over longer times than could be measured by the more conventional /sup 14/C method. Measurements of the /sup 36/Cl "bomb pulse" in soil samples from Yucca Mountain have been used to confirm that infiltration is not an important recharge mechanism.

24665 **Elimination of frequency noise from groundwater measurements.** Chien, Y.M.; Bryce, R.W.; Strait, S.R.; Yeatman, R.A. (Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352). pp 389-400 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The Basalt Waste Isolation Project (BWIP) was established to assess the suitability of basalt as a repository medium for the long-term disposal of commercial high level radioactive waste beneath the Hanford Site in south-central Washington State. In support of this work, longterm hydraulic stress tests are being run to determine areal aquifer characteristics in selected basalt formations. Groundwater response to hydraulic stresses imposed during aquifer testing may be obscured by responses to other stresses on the aquifer. Formation pressure responses during a large-scale stress test, for example, may be affected by responses to atmospheric pressure variations, earth-tides, river stage fluctuations, or irrigation pumping cycles. This paper describes two techniques that may be used to remove these extraneous transients: a systematic method and a frequency analysis method. The two potentially extraneous stress responses removed in this study were response to atmospheric pressure fluctuation and response to earth tides. The other influences mentioned above do not appear to be important for the data set evaluated in this study.

24666 **Disequilibrium of natural radionuclides in Hanford site groundwaters.** Laul, J.C.; Smith, M.R.; Johnson, V.G.; Smith, R.M. (Pacific Northwest Lab., P.O. Box 999, Richland, WA 99352). pp 401-410 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—). Contract AC06-76RL01830.

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Concentrations of U, Th, Ra, Pb and Po radionuclides are extremely low in well DC-14 groundwater of the Grande Ronde Formation. Uranium, Th and Ra appear to be highly sorbed. Relative to Rn, the retardation factors are: 1200 for U, 12000 for Th, and 1500 for Ra in DC-14 water. The /sup 234/U//sup 230/Th ratio is about 10 in the DC-14 well water and 240 in Columbia River water indicating that U is largely in the +4 oxidation state in the DC-14 water and implies a reducing environment. Colloids appear to be important for Pb and Po but not for U, Th and Ra in the DC-14 well water.

24667 **Mechanical effects associated with surface loading of dry rock due to glaciation.** Wahi, K.K.; Hunter, R. (SAIC, Suite 1200, 505 Marquette Ave. NW, Albuquerque, NM 87102). pp 671-678 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

Many scenarios of interest for a repository in the Pasco Basin begin with glaciation. Loading and unloading of joints and fractures due to the weight of ice sheets could affect the hydrologic properties of the host rock and surrounding units. Scoping calculations performed using two-dimensional numerical models with simplifying assumptions predict stress changes and uplift or subsidence caused by an advancing glacier. The magnitudes of surface uplift and subsidence predicted by the study agree well with previous independent predictions. Peak stress unloading near the repository horizon is a small fraction of the ambient stress. Any resultant aperture increase is likewise small. Based on the results of this study, mechanical loading caused by a glacier is expected to have a minimal effect on rock permeability, assuming that the excess compressive loads do not crush the rock. Possible rock failure due to shear or compression was not analyzed because the focus was on fracture aperture change due to change in normal stress across a joint or fracture.

0540 Health And Safety

REFER ALSO TO CITATION(S) 24501, 25786

24668 **Repository waste-handling operations 1998.** Connell, L.; Cottam, A.E. (Rockwell Hanford Operations, P.O. Box 800, Richland, WA 99352). pp 439-448 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—).

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The Office of Civilian Radioactive Waste Management Mission Plan and the Generic Requirements for a Mined Geologic Disposal System state that beginning in 1998, commercial spent fuel not exceeding 70,000 metric tons of heavy metal (MTHM), or a quantity of solidified high-level radioactive waste resulting from the reprocessing of such a quantity of spent fuel, will be shipped to a deep geologic repository for permanent storage. The development of a waste handling system that can process 3,000 metric tons of heavy metal annually will require the adoption of a fully automated approach. The safety and minimum exposure of personnel will be the prime goal of the repository waste handling system. A man-out-of-the-loop approach will be used in all operations including the receipt of spent fuel in shipping casks, the inspection and unloading of the spent fuel into automated hot cell facilities, the disassembly of spent fuel assemblies, the consolidation of fuel rods, and the packaging of fuel rods into heavy-walled site-specific containers. These containers are designed to contain the radionuclides for up to 1,000 years.

24669 **Determining probabilities of geologic events and processes.** Hunter, R.L.; Cranwell, R.M.; Mann, C.J. (Waste Management Systems Div., Sandia National Labs., Albuquerque, NM 87111). pp 637-646 of High-level nuclear waste disposal. Burkholder, H.C. Columbus, OH; Battelle Press (1985). (CONF-850918—). Contract AC04-76DP00789.

From International topical meeting on high level nuclear waste disposal - technology and engineering; Pasco, WA, USA (24 Sep 1985).

The Environmental Protection Agency has recently published a probabilistic standard for releases of high-level radioactive waste from a mined geologic repository. The standard sets limits for contaminant releases with more than one chance in 100 of occurring within 10,000 years, and less strict limits for releases of smaller probability. The standard offers no methods for determining probabilities of geologic events and processes, and no consensus exists in the waste-management community on how to do this. Sandia National Laboratories is developing a general method for determining probabilities of a given set of geologic events and processes. In addition, the authors will develop a repeatable method for dealing with events and processes whose probability cannot be determined.

0550 Safeguards, Inspection, And Accountability

REFER ALSO TO CITATION(S) 25444

24670 **(LA-UR—87-962) A state-of-the-art passive gamma-ray assay system.** Sampson, T.E.; Parker, J.L.; Cowder, L.R.; Kern, E.A.; Garcia, D.L.; Ensslin, N. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 7p. (CONF-870519—1). NTIS, PC A02. File Number DE87007454.

From 9. annual meeting of the European Safeguards Research and Development Association: safeguards and nuclear material management; London, UK (12 May 1987).

We report details of the development of a high-accuracy, high-precision system for the non-destructive assay of ^{235}U in solution. The system can measure samples with concentrations ranging from 0.0001 to 500 g ^{235}U/l using 200-ml samples at low concentrations, 30-ml samples at high concentrations, and 1000-s measurement times. The accuracy and precision goals of 0.1% were essentially attained for concentrations above 100 g/l. This at-line system, designed for a production plant environment, represents a significant improvement in the state of the art.

24671 **State-of-the-art technology for measurement and verification of nuclear materials.** Keepin, G.R. (International Atomic Energy Agency, Los Alamos National Lab.). pp 323-337 of Arms control verification: The technologies that make it possible. Tsipis, K.; Hafemeister, D.W.; Janeway, P. Elmsford, NY; Pergamon Books Inc. (1986).

Modern technology plays an increasingly important role in the ability of regulatory bodies such as the IAEA to account for the growing quantities of nuclear material under safeguards, including the more complicated forms and composition of nuclear materials used in the expanding fuel cycle activities of many different nations. A broad range of techniques and methods is now available for the detection, identification, assay, and verification of special nuclear materials (notably /sup 239/Pu and /sup 235/U) in various configurations and in a variety of physical and chemical forms. In this discussion, the authors focus on a selected group of state-of-the-art instruments and techniques that are used by the International Atomic Energy Agency (IAEA) in carrying out its worldwide safeguards inspection and verification responsibilities.

24672 **Verifying a fissile-material production freeze in declared facilities, with special emphasis on remote monitoring.** Weinstock, E.V.; Fainberg, A. (Brookhaven National Lab.). pp 309-322 of Arms control verification: The technologies that make it possible. Tsipis, K.; Hafemeister, D.W.; Janeway, P. Elmsford, NY; Pergamon Books Inc. (1986).

The reader will find full descriptions of the technology and methodology of monitoring nuclear materials in civilian installations such a reprocessing plants, reactors, and reactor fuel manufacturers. The authors describe the methods and equipment available for monitoring a production cutoff of fissile materials as well. A quantitative description of the instruments and methods used to meet the requirements of monitoring generated by various types of possible arms control agreements aimed at stopping the production of weapons-grade fissile materials is given. Each reprocessing or manufacturing facility presents a special set of quantitative problems. Their technical solutions and the attendant level of confidence each offers are examined. The performance characteristics of the instruments used to implement the processes are described.

0560 Legislation And Regulations

REFER ALSO TO CITATION(S) 24610, 24639, 24640

07 Physical Isotope Separation

REFER ALSO TO CITATION(S) 25408

08 HYDROGEN

REFER ALSO TO CITATION(S) 24922

0801 Production

REFER ALSO TO CITATION(S) 25151

24673 **Prospects of hydrogen production through fusion.** Kintner, E.E. (Office of Energy Research, US Dept. of Energy, Washington, DC). pp 137-154 of Nuclear technologies in a sustainable energy system. Bauer, G.S.; Mc Donald, A. New York, NY; Springer-Verlag New York Inc. (1983).

With approximately two-thirds of world energy needs supplied by petroleum and natural gas, the expected future shortage of these resources will lead to a need for substitute fuels early in the next century. Synthetic fuels produced by conversion of the relatively abundant resources of coal can be expected to play a major role in filling this need. These resources can be substantially extended, and the environmental impacts of the conversion process considerably reduced, if external sources of hydrogen and process heat are provided. Nuclear fusion is a future inexhaustible energy source which can provide both hydrogen and high-temperature process heat. Moreover, certain unique features of fusion suggest the possibility of significant increases in overall process efficiencies through operation at very high temperatures. Studies are underway on the feasibility of coupling high-temperature electrolysis and thermochemical cycle processes with a fusion reactor and thus achieving splitting of water by fusion energy.

0808 Properties

24674 **(DPST—87-203) Finite-difference program for hydrogen diffusion: Example problems manual.** Kain, K.E. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 5 Jan 1987. Contract AC09-76SR00001. 320p. NTIS, PC A14. File Number DE87007515.

The finite-difference program "DIFF.BAS" calculates hydrogen and helium concentration profiles for hydrogen systems. The program can be used to determine the possibility of hydrogen/helium embrittlement and estimate the health hazards associated with tritium permeation. For these safety analyses, a computer program has been written for special applications of interest to the Savannah River Laboratory and the Department of Energy complex. Over 160 possible combinations of structure shape, isotope calculations, material properties and boundary conditions are available. This does not include the infinite variations in fill data, exposure sequences, time, temperatures and structure sizes which the program can accommodate. The example manual cannot address all of these possibilities. However, all options have been investigated and are included in this manual containing 61 example problems.

09 OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 24893

0901 Hydrocarbon Fuels

REFER ALSO TO CITATION(S) 24402, 24718, 25130, 25380, 25382, 25386

24675 **(CONF-8610227—1) Migration and methanogens: A review of current landfill gas field research at ANL.** Bogner, J.; Torpy, M.; Rose, C.; Vogt, M.; Gartman, D.; Moore, C. (Argonne National Lab., IL (USA); Geotechnics, Inc., Columbus, OH (USA)). 1986. Contract W-31109-ENG-38. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87004836.

From United Kingdom/United States conference on energy from landfill gas; Solihull, UK (28 Oct 1986).

Landfill gas recovery research at Argonne National Laboratory is focusing on a project studying gas movement through landfill cover materials and a pilot investigation of microbial populations in landfills. Vertical gas pressure and concentration gradients between the top of refuse and the landfill cover are being examined. In particular, changes in the vertical gradients indicative of changes in magnitude and direction of pressure or diffusional flow with time are being monitored. This study emphasizes changes in vertical pressure and concentration gradients related to barometric pressure and other meteorological variables, soil moisture changes, and pumping rates at simulated recovery wells. Preliminary results suggest that changes in soil-gas pressures in the landfill cover and top of refuse closely follow changes in barometric pressure. Measurable concentration gradients exist between the top of refuse and the cover materials indicating that diffusion is a major mechanism for gas movement, particularly during dry weather when pressure gradients are negligible. A pilot investigation has begun on microbial populations in sanitary landfills. First, a series of leachate samples from various depths at the Blackwell Forest Preserve Landfill were evaluated for microbial populations, selected chemical constituents, and methane production. Diverse motile populations of fluorescing organisms were found in selected samples. 19 refs., 6 figs., 3 tabs.

24676 **(DOE/ER/13454—2) Thermodynamics and rate of methanol conversion to hydrocarbons on zeolites: Progress report for period September 15, 1985 to February 15, 1987.** Alberty, R.A. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry). 1987. Contract FG02-85ER13454. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006365.

Equilibrium calculations were performed on two homologous series that are produced in the methanol to gasoline conversion catalyzed by zeolite ZSM-5. At low carbon numbers in both homologous series the distribution of isomer groups is what is expected from the Gibbs energies of formation, but at higher carbon numbers the correct distribution of isomer groups can only be calculated by taking the selectivity of the ZSM-5 catalyst into account. The statistical mechanical basis was discovered for equilibrium calculations using isomer groups and for equilibrium calculations using homologous series groups at a fixed partial pressure of ethylene. For a homologous series at equilibrium the standard Gibbs energy of formation, enthalpy of formation, entropy and heat capacity of the homologous series may be calculated as a function of ethylene pressure. This means that chemical reactions can be written in terms of homologous series groups.

24677 **(NP—7770076) Kinetic characterisation of different catalysts for the methanation of residual CO in hydrogen.** Kreuzer, D. (Bochum Univ. (Germany, F.R.). Abt. fuer Chemie). 8 Jul 1985. 165p. (In German). NTIS (US Sales Only), PC A08. File Number DE87770076.

The micro- and macrokinetics of the methanation of residual CO in H/N mixtures was investigated using two commercial catalysts. There is already a kinetic approach to the microkinetics of one of the two catalysts, which is based on mechanistic assumptions. The author intended to find out whether this approach is specific for a single catalyst or whether it applies also to other catalysts. This was done by a process of discrimination between various models currently proposed in the relevant literature before simulating the macrokinetics with this model equation. The calculated and measured macrokinetics were compared. The kinetic data were also used for comparing the activities of the two catalysts.

24678 **(PB—87-147443/XAB) Microbiological and biochemical studies towards optimization of substrate utilization by methanogenic bacteria. Final report, December 1982-February 1986.** Ferry, J.G. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Mar 1986. 91p. NTIS, PC A05/MF A01.

See also report dated Dec 84, PB—85-188332.

The microbiology of acetate conversion was studied. New acetotrophic and methylotrophic isolates were characterized. Biotin, Fe, Co and Ni were shown to be required for growth on methylotrophic substrates. A novel technique was developed for the large-scale culture of acetotrophs. The pathway of acetate conversion to methane and carbon dioxide was studied. It was shown that the methyl group of acetate was transferred to coenzyme M. The levels of an enzyme system that demethylates methyl coenzyme M and requires carbon monoxide was correlated with growth on acetate which implicates this system in the pathway of acetate to methane. However, free carbon monoxide was shown not to be an intermediate in the pathway which suggests a reduced Cl intermediate is formed from the carboxyl group of acetate. The carbon monoxide dehydrogenase was purified and characterized. In the presence of cyanide, EPR signals from the iron-sulfur and flavin centers are unmasked, which allows further study of the EPR properties of these centers to elucidate the mechanism of action of the enzyme.

24679 **(PB—87-153896/XAB) Biogasification of Walt Disney World biomass waste blend. Final report, January 1982-December 1985.** Biljetina, R.; Chynoweth, D.P.; Srivastava, V.J.; Janulis, J.A.; Razik, A. (Institute of Gas Technology, Chicago, IL (USA)). Oct 1986. 180p. NTIS, PC A09/MF A01.

See also PB—86-123668.

The objective of the research is to develop efficient processes for conversion of biomass-waste blends to methane and other resources. To evaluate the technical and economic feasibility, an experimental test unit (ETU) was designed and operated at the Reedy Creek Wastewater Treatment Plant at Walt Disney World in Lake Buena Vista, Florida. The facility integrates a biomethanogenic-conversion process with a wastewater-treatment process employing water hyacinth ponds for secondary and tertiary treatment of sewage. Harvested water hyacinth is subsequently combined with sludge from the primary wastewater clarifier and fed at 1-wet-ton per day to the ETU digester. This results in the production of methane and other useful products. The digester was operated as a non-mixed, solids concentrating digester to encourage higher solids and microorganism retention times. Data collected during six steady-state operating periods confirmed earlier laboratory observations that this digester consistently produces 15 to 25% higher methane yields and conversions when compared to conventional stirred-tank digester. Digester operation was evaluated at different loading rates, solids blend ratios and feed configurations. Results from the program have provided a data base for the design of larger conversion systems.

24680 **(SI-R—840129-1) New process for converting methane. An economic evaluation.** Halvorsen, S.; Ofstad, E.B. (Sentralinstitutt for Industriell Forskning, Oslo (Norway)). Jan 1985. 74p. (In Norwegian). NTIS (US Sales Only), PC A04. File Number DE87751693.

An economic evaluation of a possible process for direct conversion of methane to right boiling hydrocarbons is carried out. The process is based on catalytic conversion of methane in the presence of a coupling component. This component binds liberated hydrogen during the reaction and can later be regenerated by oxidation and recirculated. Two possible process alternatives are considered. The first alternative is based on an existing patent. The second alternative is based on the same patent but the use of a more active catalyst than in the patent is assumed. In the latter case the activity is chosen through relative careful optimistic consideration of the process possibilities. Economic information about this type of process has not been found in the literature. Profitability considerations for the two process alternatives is therefore based on fairly rough estimates of the investments and the operating costs. The results indicate that the alternative based on the patent hardly would be economically attractive. However, the more optimistic alternative may be economically interesting. A natural comparison between the two process alternatives with saturated gas based Fischer-Tropsch synthesis or Mobil MTG-process leads mainly to same conclutions regarding process economy as above. Based on these considerations we think it is a challenge to develop a better catalytic system for the methane conversion process. 7 appendices, 32 tables, 13 drawings, 28 references.

0902 Alcohol Fuels

REFER ALSO TO CITATION(S) 24404, 24720

24681 **(BNL—39188) Low temperature methanol process.** O'Hare, T.E.; Sapienza, R.S.; Mahajan, D.; Skaperdas, G.T. (Brookhaven National Lab., Upton, NY (USA)). Jun 1986. Contract AC02-76CH00016. 11p. (CONF-8606274—1). NTIS MF A01; 2; GPO Dep. File Number DE87006462.

From 21. American Chemical Society state-of-the-art symposium Division of Industrial and Engineering Chemistry; Marco Island, FL, USA (15 Jun 1986).

The world's abundant natural gas resources could provide methanol in fuel quantities to the utility system. Natural gas liquefaction is the current major option available for international export transport of natural gas. Gas production is on the increase and international trade even more so, with LNG making most progress. The further penetration of natural gas into distant markets can be substantially increased by a new methanol synthesis process under development. The new methanol process is made possible by the discovery of a catalyst that drops synthesis temperatures from about 275°C to about 100°C. Furthermore, the new catalyst is a liquid phase system, which permits the synthesis reaction to proceed at fully isothermal conditions. Therefore, the new low temperature liquid catalyst can convert synthesis gas completely to methanol in a single pass through the methanol synthesis reactor. This characteristic leads to a further major improvement in the methanol plant. Atmospheric nitrogen can be tolerated in the synthesis gas, and still the volume of gas fed to the reactor can be smaller than the volume of gas that must be fed to the reactor when accommodating the very low conversions furnished by the best of currently available catalysts. The energy disadvantage of the methanol option must be balanced against the advantage of a much lower capital investment requirement made possible by the new BNL synthesis. Preliminary estimates show that methanol conversion and shipping require an investment for liquefaction to methanol, and shipping liquefied methanol that can range from 35 to 50% of that needed for the LNG plant and LNG shipping fleet.

24682 **(UCLDE-DP—86-02) Social cost-benefit study of ethanol production in Brazil.** Seroa da Motta, R. (University Coll., London (UK). Dept. of Economics). 1986. 119p. British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 6BQ.

An assessment of the social viability of The Brazilian National Alcohol Programme (PROALCOOL) is presented. National parameter values are estimated following the Little-Mirrlees methods, and alternative appraisal procedures are developed to determine the social cost of ethanol. The main data base is given by the breakdown of the cost of production of ethanol for the 1981/1982 crop year in three states. Results suggest that the current social cost of ethanol is above the cost of either importing or exporting gasoline. Sensitivity analysis and estimates indicating that the social viability of the PROALCOOL will only be achieved by the middle of the next decade are discussed.

0904 Solid Waste And Wood Fuels

REFER ALSO TO CITATION(S) 24457, 24696, 24697, 24720

24683 (DOE/CE/30792—T34-Vol.1) Biomass energy systems: An investment decision-making guide for the small business: Volume 1. Smith, P.M.; Sinclair, S.A. (Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development). [1986]. Contract AI01-83CE30792. 58p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007868.

Biomass fuels represent an alternative to conventional fossil fuels for boiler-firing. This workbook presents an easy-to-use investment decision-making guide for the evaluation of biomass energy installations or conversions. The economic analysis presented in this workbook is intended to serve as a first-level tool for identifying potential candidates for biomass energy. Final investment decisions should be considered only after calculating more detailed and company-specific costs based upon consultation with accountants and/or engineers. Additionally, fuel costs and availability, including projected fluctuations, should be carefully examined as these costs represent a major factor in the investment decision. Workbook procedure generally involves two steps, first data collection of system, fuel and financial data, and second test calculations of savings, cash flow and payback period. Based upon the economic test calculations, the results should be evaluated in terms of project feasibility. Should the proposed test calculations appear favorable, management is encouraged to consider a more in-depth analysis. At this point, consideration of potential sources of capital may be appropriate. A complementary Southeast Regional Biomass Energy Program (SERBEP) document, "Financing Options For Biomass Energy Systems: discusses three major options or sources of financing: commercial bank loans, leases, and industrial development bonds. 28 refs.

24684 (DOE/CE/30792—T37) Analyzing market constraints in woody biomass energy production: Final report. Young, T.M.; Ostermeier, D.M. (Tennessee Univ., Knoxville (USA). Dept. of Forestry, Wildlife and Fisheries). Sep 1986. Contract AI01-83CE30792. 187p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87007875.

Two surveys were used to identify the competitive market segment and barriers to industrial wood energy use. The first of these is of national scope and relies on information from 55 industries and institutions currently using wood fuel. The second relies on information from 367 conventional fuel using industries and institutions. Policy review and a sample of expert opinion are used to outline alternative methods of removing existing constraints. Five constraints preventing wood energy use were identified: a general lack of knowledge concerning industrial wood energy and a poor perception regarding its application; a high capital costs of conversion to a wood energy system; problems associated with wood fuel handling; concern regarding the availability of long-term supply; and lack of knowledge about the proper operation of a wood energy system. The study also sought identity alternative methods of removing these constraints. Some of these methods include direct support in the form of grants and low interest loans to potential candidates, creation of tax incentives and information dissemination. Five alternative policies are proposed. Benign Neglect - few or no special programs directed toward removing existing barriers to industrial wood energy use; Status Quo - the continuation of existing programs indefinitely with no attempts to modify or expand these programs substantially; Reform Option - a modification of status quo that views present expenditure levels as appropriate but feels reforms and modifications in existing programs are desirable; Market Improvement - improving the operation of the industrial wood energy market through improving information flows; and Increased Government Involvement - substantial additional expenditures for removing barriers such as direct subsidy programs, tax incentives, technical assistance. 46 refs., 4 figs., 47 tabs.

24685 (DOE/CE/30792—T38) Permits, regulations for biomass energy facilities in the Southeast. (Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development). Aug 1986. Contract AI01-83CE30792. 118p. NTIS MF A01; 2; GPO Dep. File Number DE87007870.

Biomass fuels can be converted to energy through direct combustion, gasification, anaerobic digestion or fermentation. A study conducted by the Thayer School of Engineering, Dartmouth College, anticipates a large increase in the use of wood for energy in the South. It predicts that by the year 2000, nearly 20% of all industrial boilers in the south will be wood-fired. If this prediction is correct, a number of new biomass facilities will be constructed and existing energy systems will be converted to biomass. This guidebook is written for project developers and local and state agencies to explain the permits and regulations which the Southeastern states require before construction of biomass projects. Plant construction can include not only new equipment to convert biomass fuels to energy, but the redesign of existing equipment to use biomass fuels. Several biomass project planning tools including a questionnaire to determine if you need a permit and a calendar for timing permit applications are provided. Possible environmental impacts associated with facilities and kinds of permits facilities are likely to need are described. If biomass facilities are large or sited in sensitive areas, environmental impacts are significant to project planning and need special environmental investigations. For most projects, environmental considerations require careful siting, emissions control and routine permits. State and federal regulatory agencies, their permits and standards for construction and operation are described. Regulations discussed include air quality, water quality, solid waste, hazardous waste disposal, noise, water use, zoning and land use, facility siting, safety and physical plant regulations, and occupational health and safety requirements.

24686 (DOE/CE/30792—T39) Co-combustion of biomass and fossil fuel(s): A survey of the state of the art. Makansi, J. (Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development; Tennessee Valley Authority, Muscle Shoals, AL (USA). Southeastern Regional Biomass Energy Program). Sep 1986. Contract AI01-83CE30792. 139p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87007874.

Co-combustion of biomass and fossil fuels, or two distinctly different biomass fuels has been practiced for years by industries with a readily available supply of a biomass fuel for energy-derivation purposes. Other industries practicing this technology have done so primarily to dispose of the biomass as a waste. In this survey are utility, industry, and commercial sites who have practiced co-combustion, are now practicing co-combustion either on a continuous or intermittent basis, or have conducted a feasibility-, pilot-, or demonstration-type study to investigate the technology. In short, the survey is a list of sites that are interested in the technology because of their past, present, or possible future experience. 57 refs.

24687 (DOE/CE/30792—T40) Wood energy guide for agricultural and small commercial applications. Jahn, L.G.; Elliott, R.N. III. (North Carolina State Univ., Raleigh (USA). Dept. of Extension Forest Resources). [1987]. Contract AI01-83CE30792. 37p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007876.

This manual is designed to help evaluate the potential for using wood as an energy source in an agricultural or small commercial application requiring less than 10 million Btus per hour. Topics covered include wood as a resource; heating systems and combustion equipment; storage, handling, and feeding systems; economic considerations; and sources of equipment. Also included are a glossary of terms and a list of sources from which you can obtain additional information. The appendices provide an analysis of the cost of wood as a fuel and an analysis of economic assumptions. 34 refs., 14 figs., 24 tabs.

24688 (DOE/RA/50307—T1) **Waste-to-energy: San Bernardino County (valley area): Final report.** (Brown, Vence and Associates, San Francisco, CA (USA)). May 1986. Contract FG01-80RA50307. 30p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008110.

Purpose of the grant is to assist the County of San Bernardino in implementing a waste-to-energy project. Major work completed and summarized in this report is as follows: project feasibility study; request for proposals from private industry to implement the project; proposal evaluations; and memorandum of understanding with the selected proposer to develop the project.

13 HYDRO ENERGY

24689 (DOE/BP/39220—T1) **The Salish and Kootenai small-scale Hydro Power Plan: Site identification and inventory water resources development planning.** Farrell, R. (Confederated Salish and Kootenai Tribes, Pablo, MT (USA)). 31 Jan 1984. Contract FG79-83BP39220. 103p. NTIS MF A01; 2; GPO Dep. File Number DE87007541.

Purpose of the Hydro Power Plan is to identify all the sites on the Flathead Reservation that have any potential for small-scale hydropower development and to quantify the estimated generation or output that can be obtained from the unrestricted production of each. This plan presents the preliminary findings of the Inventory Analysis, an overview of each site and its qualifications as a potential hydropower producer, as well as a summary and interpretation of what the results mean and how these findings will be used in follow-up planning and development.

1301 Resources And Availability

24690 (EFI-TR—3166) **Model and algorithms for the regulation of discharges in river system.** Foss, B.A.; Haug, J.E.; Aam, S. (Elektrisitetsforsyningens Forskningsinstitutt, Trondheim (Norway)). 9 Apr 1985. 70p. (In Norwegian). NTIS (US Sales Only), MF A01. File Number DE87751701.

The report deals with the regulation of river systems with free influxes. Local stretches of rivers are studied in particular. A computer program, ELVEREG, is developed for this purpose. 23 drawings.

24691 (STF—60A85154) **Seminar on a model providing physical characterization of river systems and Insteam Flow Incremental Methodology (IFIM).** Vaskinn, K.A. (Norsk Hydroteknisk Lab., Trondheim). Dec 1985. 127p. (In Norwegian). NTIS (US Sales Only), MF A01. File Number DE87751702.

The report deals with a consequence analysis on the regulation of river systems. A flow model (Fysisk Beskrivende Vassdragsmodell) designed for Norwegian conditions and the model PHABSIM in combination with the Instream Flow Incremental Methodology (IFIM) are discussed in order to explain the changes of hydrophysical relations and habitat conditions in connection with the change of discharges. The recorded data can easily be put into the coherence of other types of data from river systems and adjacent areas. The IFIM involves a wide range of agencies, professions, and interests. Decisions made regarding stream flow allocations require the evaluation of numerous factors over a range of events. Certain factors are used to judge the benefits and liabilities resulting from a particular management practice. The role of technical information in the decision process is to quantify charges in the decision variable in response to various management alternatives. The IFIM is designed for iterative problem solving in this context of decision making. 20 drawings, 3 tables.

1306 Environmental Aspects

REFER ALSO TO CITATION(S) 24691

24692 (TVA/ONRED/WRF—87/4) **Research and development of fish passage technology.** Hackney, P.A. (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). Dec 1986. 3p. NTIS, PC A02/MF A01. File Number DE87900618.

Any fish passage provided at TVA's John Sevier Fossil Plant (JSF) would involve only warmwater species. Although some anadromous (marine) warmwater species (e.g., American shad, blueback herring) are currently passed upstream and downstream through structures deliberately built for that purpose, effectiveness of this technology for passage of adults and young of potential target species (e.g., paddlefish and sauger/walleye) in Cherokee Reservoir is unproven. Downstream passage is by far the larger and more poorly understood subject of fish migration and should be investigated first. Currently, the Electric Power Research Institute (EPRI) is conducting research on downstream fish passage (Project RP 2694). It will ultimately be necessary to adapt this information to the target species and site specificity at JSF.

24693 (TVA/ONRED/WRF—87/5) **Assessment of fish passage technology applicable to John Sevier detention dam.** Pasch, R.W. (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). Dec 1986. 4p. NTIS, PC A02/MF A01. File Number DE87900617.

This report provides an assessment of existing technologies and developments in fish passage technology applicable to moving sauger and paddlefish upstream and downstream of the John Sevier detention dam. (ACR)

14 SOLAR ENERGY

1401 Resources And Availability

24694 **Solar resource assessments in developing countries.** Maxwell, E.L. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 2582-2586 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The Solar Energy Research Institute (SERI) was invited by the Kingdom of Morocco and the United States Agency for International Development (AID) to prepare a plan for the assessment of solar a wind resources in Morocco. The solar part of the resource assessment plan developed for Morocco is described and should be applicable to many developing countries in which limited funds are available for assessment efforts; there is an immediate need for solar resource data; very little or no historical insolation data are available; a network of meteorological stations exist which monitor percent possible sunshine, wind, temperature, precipitation, and cloud cover; and historical and/or current images are available from a weather satellite such as METEOSAT, INAT, GMS, or GOES.

1403 Economics

REFER ALSO TO CITATION(S) 24741, 24890

1405 Solar Energy Conversion

REFER ALSO TO CITATION(S) 24683, 24686, 24893, 24952, 24953, 24956, 24957, 25512, 25513, 25514, 25867, 25872

24695 (CONF-870364—1) **Are increased yields in coppice systems a myth?.** Wright, L. L. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006608.

From Energy from biomass and wastes; Orlando, FL, USA (16 Mar 1987).

One advantage attributed to coppice systems is that wood production costs will be decreased because coppice yields are usually greater than seedling yields at the same age. Observed increases in coppice yields over seedling yields vary from 0 to 300%. These observed fast rates of coppice regrowth have generated the idea that coppicing will increase total yields. Biomass yield data from the Department of Energy's Short Rotation Woody Crops Program suggest that short-rotation coppice stands attain high yields at an early age but do not increase total production levels over stands of equal spacing and culture, but longer rotation. Coppiced stands normally show some lag in accumulation of woody material, compared to unharvested stands of the same age, even if the rates of coppice production are very high. In trials where rotation lengths of 2 and 4 years were imposed, the 2-year rotation treatment resulted in equal or lower total yields than the 4-year rotation treatment in 60 of 65 comparisons. Very few data are available for comparing biomass yields from 4-year rotations with biomass yields from longer rotations, but the few examples available show the same pattern. Although short-rotation coppice practices alone may not increase total yields, it is anticipated that coppice practices in conjunction with additional intensive culture practices (including use of selected clones) can increase yields, while at the same time providing early returns on investments and avoiding replanting costs. 20 refs., 6 figs.

24696 **(DOE/CE/30792—T34-Vol.2) Financing options for biomass energy systems: Volume 2.** (Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development; Coopers and Lybrand, Atlanta, GA (USA)). Apr 1986. Contract AI01-83CE30792. 39p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007869.

This manual on financing alternatives for funding biomass energy systems was prepared through funding provided by the Southeastern Regional Biomass Energy Program (SERBEP), which is administered by the Tennessee Valley Authority for the US Department of Energy. It is intended for use by private industry in evaluating the attractiveness of biomass systems as an alternative energy source. The manual focuses on considerations, alternatives and issues involved in obtaining project funding, discusses the major financing options and their tax implications. Basically, in attempting to finance any project, a company must convince a lender (or some representative of a lender such as a bond underwriter) of the creditworthiness of the company and the soundness of the project. Each lender has his own definition and criteria for "creditworthiness." These typically involve measures of earning power and/or measures of the kinds of assets (property, inventory or accounts receivable) a company possesses. It is important for a potential borrower to have a sense of the criteria these lenders use and the effect that each method of financing will have on the company's profitability. This manual is intended to guide companies through analysis of the financing considerations of a biomass project, which are distinct from the operating considerations. 7 refs.

24697 **(DOE/CE/30792—T35) Cogeneration from biofuels: A technical guidebook.** Easterly, J.L.; Lowenstein, M.Z. (Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development). Oct 1986. Contract AI01-83CE30792. 118p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007871.

Cogeneration, the simultaneous production of more than one form of useful energy, has long been used by industry as a means of producing both thermal and electric energy to meet on-site process requirements. Biomass feedstocks such as wood are currently used as the fuel in many cogeneration systems, yet there are substantial opportunities for expanding the use of these feedstocks in the southeastern region of the US. The extensive quantity and diversity of biomass resources in the Southeast provide an excellent opportunity to reduce the use of fossil fuels. This guidebook focuses primarily on issues related to the use of biomass fuels for cogeneration in the Southeast. It is targeted toward those plant managers and engineers who could use a biomass fueled system but are not knowledgeable or aware of the potential or applications of biomass fuel for cogeneration. The guidebook emphasizes a systems level understanding and is not intended to be a detailed "nuts and bolts" handbook. Detailed technical information is limited to biomass fuel characteristics, an area where engineers' standard reference documents may be inadequate. 30 refs., 30 figs., 26 tabs.

24698 **(DOE/CE/30792—T36) Case studies of biomass energy facilities in the Southeastern US.** (Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development; Meridian Corp., Falls Church, VA (USA)). Aug 1986. Contract AI01-83CE30792. 195p. NTIS, PC A09. File Number DE87007872.

This collection of case studies demonstrates the diversity of biomass energy systems that are "here and now" a technical and economic reality throughout the region. The attached map shows the regional dispersion of the case study facilities, with each state represented by a minimum of four case studies. Following the map is a matrix which shows the diversity of biomass options in terms of the types of facilities and industrial processes served and in terms of the biomass feedstocks used and the conversion systems employed. The matrix lists each case study, alphabetically by state and alphabetically within states, and summarizes the technologies employed at each. This can be used as an index for locating facilities using technologies of particular interest. The case studies themselves follow. These are arranged alphabetically by states and within states. Each case study is also numbered to correspond with the listing in the matrix.

24699 **(DOE/CS/66001—9) ECUT: Energy Conversion and Utilization Technologies Program: Biocatalysis project: Annual report, FY 1985.** (Jet Propulsion Lab., Pasadena, CA (USA)). 30 Jul 1986. Contract AI01-81CS66001. 44p. (JPL-PUB—86-32). NTIS, PC A03/MF A01; GPO Dep. File Number DE87005233.

This report presents the fiscal year 1985 activities, accomplishments, and planned research efforts of the Biocatalysis Project of the US Department of Energy, Energy Conversion and Utilization Technologies Program. In the Molecular Moedling and Applied Genetics work element, research focused on modeling and simulation studies to establish the physiological basis of high temperature tolerance in a selected enzyme and the catalytic mechanisms of three species of another enzyme, and on determining the degree of plamid amplification and stability of several DNA bacterial strains where the DNA plasmid had been inserted directly into the bacterial chromosome. In the Bioprocess Engineering work element, research focused on studies of plasmid propagation and the generation of models for plasmid replification and gene expression control in recombinant microorganisms, on developing methods for preparing immobilized biocatalyst beads for use in a fluidized bed reactor system, and on developing an enzyme encapsulation method for suspension in non-aqueous solutions. In the Process Design and Analysis work element research focused on further refinement of a test case simulation of the economics and energy efficiency of alternative biocatalyzed production processes, on developing a candidate bioprocess to determine potential for reduced energy consumption and facility/operating costs, and on a techno-economic assessment of potential advancements in microbial ammonia production.

24700 **(DOE/ER/12015—T2) Studies of Photosystem II using artificial donors: Progress report, 1984.** (Martin Marietta Labs., Baltimore, MD (USA)). 1984. Contract AC02-82ER12015. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006262.

We have been using two analytical techniques developed inhouse to study aspects of PS II function. Mass spectrometric experiments made use of a "flash-yield inlet" that provided good time response (<1 s) and high sensitivity (pmoles/flash). Spectrophotometric studies were carried out using an apparatus that was specially designed for kinetic measurements of light-induced absorbance changes (250 to 800 nm) in the (sub-) ms time range. Many of these studies made use of "competitive inhibitors" of H_2O oxidation including NH_2OH and NH_2NH_2. These compounds, which are analogs of (two molecules of) H_2O, share the ability to compete with and override H_2O oxidation without destroying the O_2 system. During the course of this program we found it necessary to modify our mass spectrometer inlet system. This modification, which really entailed the development of a new system, is described. 6 figs.

24701 (DOE/JPL—7004490) **Laser-assisted solar cell metallization processing: Final report for the period September 13, 1983 to September 30, 1986.** Gupta, S.; Rohatgi, A.; McMullin, P.G.; Palaschak, P.A.; O'Keeffe, T.W.; Meier, D.L.; Rai-Choudhury, P. (Jet Propulsion Lab., Pasadena, CA (USA); Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 8 Jan 1986. Contract NAS-7-100-956615. 138p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87004490.

Laser-assisted processing techniques for producing high-quality solar cell metallization patterns have been investigated, developed, and characterized. During the early stages, preliminary investigations were carried out on a variety of promising laser-assisted metallization schemes, and the best of these was selected for further development. A comprehensive literature search initially yielded information on state-of-the-art laser-assisted techniques for metal deposition such as laser chemical vapor deposition and laser photolysis of organometallics, as well as laser-enhanced electroplating. Initial experiments on laser-enhanced electroplating yielded very promising results with linewidths as narrow as 25 μm and local plating speeds as high as 12 μm/s being achieved. Metal deposition experiments were carried out utilizing laser-assisted pyrolysis of a variety of metal-bearing polymer films and metallo-organic inks spun onto silicon substrates. Argon-ion laser decomposition of spun-on silver neodecanoate ink, a generic metallo-organic ink, yielded fine, adherent silver lines. Solar cell comb metallization patterns were written using this technique, each pattern being written in a fraction of a second. An economic evaluation yielded the conclusion that laser-assisted pyrolysis of spun-on silver neodecanoate is the most promising of all the metallization techniques that were investigated in this contract. Accordingly, maximum effort was directed toward the development of this technique. Linewidth studies were carried out as a function of laser power, scan speed, and film thickness. Solar cells were fabricated and characterized using this metallization scheme.

24702 (DOE/JPL—7006117) **Development and analysis of silicon solar cells near 20% efficiency in the Flat Plate Solar Array Project: Final report.** Wolf, M.; Newhouse, M. (Pennsylvania Univ., Philadelphia (USA). Moore School of Electrical Engineering). 22 Oct 1986. Contract NAS-7-100-956290. 228p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE87006117.

The project reported consisted of two phases. The objective of the first was, through a multi-variable experiment, to determine those process parameters in CVD epitaxial deposition which would yield adequate minority carrier lifetimes in the deposited layers to make them suitable for use in crystalline silicon solar cells. A second task was to develop a method for the measurement of these lifetimes which could not be accessed with the commonly applied methods. The objective of the second phase was to refine the lifetime measuring method called Absolute Light Beam Induced Current (ASLBIC), establish its reliability and transportability, perform a comparative assessment of other potentially applicable methods, and possible select or develop a better method. The study on minority carrier lifetimes obtainable in CVD layers is summarized. The ASLBIC method is described, followed by a theoretical discussion of dynamic techniques, applications and implementations. The merits and limitations of the various experimental methods are compared. (LEW)

24703 (N—87-12048) **Results of the 1986 NASA/JPL Balloon Flight Solar Calibration Program.** Anspaugh, B.E.; Weiss, R.S. (Jet Propulsion Lab., Pasadena, CA (USA)). Nov 1986. 41p. (NASA-CR—179916; JPL-PUB—86-42; NAS—1.26:179916). NTIS, PC A03/MF A01.

The 1986 solar cell calibration balloon flight was successfully completed on July 15, 1986, meeting all objectives of the program. Thirty modules were carried to an altitude of 118,000 ft (36.0 km). The calibrated cells can now be used as reference standards in simulator testing of cells and arrays.

24704 (N—87-16742, pp vp) **Inversion layer MOS solar cells.** Ho, F.D. Nov 1986. NTIS, PC A99/MF E04. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—).

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

Inversion layer (IL) Metal Oxide Semiconductor (MOS) solar cells were fabricated. The fabrication technique and problems are discussed. A plan for modeling IL cells is presented. Future work in this area is addressed.

24705 (ORNL/M—326) **Ninth symposium on biotechnology for fuels and chemicals: Program and abstracts.** (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 126p. (CONF-870523—Absts.). NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87007692.

From 9. symposium on biotechnology for fuels and chemicals; Boulder, CO, USA (5 May 1987).

The program and abstracts are provided for the Ninth Symposium on Biotechnology for Fuels and Chemicals. This program contains the abstracts for individual oral presentations on thermal and chemical processing, on applied biological research, on bioengineering research, on microbial interactions with coal and on problems and challenges in commercializing biotechnology. (DT)

24706 (ORNL/TM—10203) **Characterization of the southwest United States for the production of biomass energy crops.** Salk, M.S.; Folger, A.G. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 181p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87007914.

The southwest United States, an area of diverse climate, topography, terrain, soils, and vegetation, is characterized to determine the feasibility of growing terrestrial energy crops there. The emphasis in the study is on delineating general zones of relative resource and environmental suitability, which are then evaluated to estimate the potential of the region for energy crop production. 100 refs., 25 figs., 24 tabs.

24707 (PB—87-146668/XAB) **Biomass yields for small trees, shrubs, and herbs in northern lake states forests. Forest Service research paper.** Smith, W.B. (Forest Service, St. Paul, MN (USA). North Central Forest Experiment Station). 1986. 14p. (FSRP-NC—277). NTIS, PC A02/MF A01.

Biomass yield information by forest type is presented for lesser vegetation in northern Michigan, Wisconsin, and Minnesota based on data from recent field inventories.

24708 (SERI/CP—233-2959) **Proceedings of the tenth DOE solar photochemistry research conference.** (Solar Energy Research Inst., Golden, CO (USA); Windsor Univ., Ontario (Canada). Dept. of Chemistry). 1986. Contract AC02-83CH10093. 245p. (CONF-8606279—Summs.). NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE87006421.

From 10. DOE solar photochemistry research conference; Ontario, Canada (8 Jun 1986).

The Tenth DOE Solar Photochemistry Research conference cosponsored by the Division of Chemical Sciences, Office of Basic Energy Sciences, US Department of Energy and the Natural Sciences and Engineering Research Council of Canada was held on June 8-12, 1986, at the Pillar and Post Conference Center in Niagara-on-the-Lake, Ontario, Canada. This volume contains the program of the meeting, the abstracts of 29 formal presentations and 46 posters. In commemoration of the 10th anniversary of this conference, a special session was held in which James R. Bolton of the University of Western Ontario presented an overview of past accomplishments and served as moderator for a panel comprised of Melvin Calvin, Nick Serpone, Michael Wasielewski and Mark Wrighton, who discussed future directions of solar photochemical conversion research. A transcript of these proceedings is included in this volume.

24709 (SERI/CP—252-2714, pp 1-18) **Surface plasmon conversion.** Arrison, A.; Chubb, D. (National Aeronautics and Space Administration, Cleveland, OH). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

The goal of advanced thin film device research is to survey the many new advances in the field of optoelectronics and apply these new developments to devise high efficiency (greater than 30%) photovoltaic and non-photovoltaic solar cell concepts. One such concept that has received considerable attention is the surface plasmon solar cell. It is well known that two of the major loss mechanisms in a typical solar cell are that light with an energy below the semiconductor bandgap cannot be utilized, and that electron-hole pairs that are created by photons with energies greater than the bandgap will convert their excess energy to heat. The surface plasmon solar cell was conceived with the goal of overcoming these difficulties. The device involves parallel processing of surface plasma waves on a metal film, and energy conversion by tunneling in metal-oxide-semiconductors-metal diodes. The feasibility of this concept is discussed.

24710 (SERI/CP—252-2714, pp 19-28) **Lepcon: light/electric power conversion.** Marks, A.; Bourke, E. II. (Phototherm, Inc., Nashua, NH). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

An array of submicrometer antennas deposited on a glass substrate can directly convert solar energy into electric power, with four times the efficiency and at a tenth of the cost of traditional photovoltaic converters. Traditional photovoltaic cells are semiconductor devices consisting of a sandwich of two materials with differing electrical properties. Incoming solar photons are absorbed at the junction of the two materials, creating pairs of electrons and electron vacancies (holes) that flow through the material as the generated electric current. The most advanced working photovoltaic cells operate at only 15 to 20% efficiency. In the Lepcon solar converter, however, needlelike metallic dipole antennas 0.18 micrometer long - half as long as the wavelength of light - are deposited and oriented on a glass substrate. Incoming electromagnetic radiation sets up an oscillation in the submicrometer-size dipoles just as radio waves set up an oscillation in a much larger radio antenna. This oscillation sets up an alternating current whose resonant frequency depends on the length of the antenna. A rectifier then converts the alternating current into a direct current. The device is described.

24711 (SERI/CP—252-2714, pp 29-49) **Black body pumped lasers.** Christiansen, W. (Univ. of Washington, Seattle). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

Direct conversion of sunlight into laser light without the need for a complicated intermediate step of energy conversion is a significant advantage for high-power solar pumped CW lasers. While the principle of broadband optical pumping using flashlamps to achieve a working laser is well known and has been put into practice with the ruby laser and dye laser, broadband pumping of gas lasers has not been so extensively studied. Recently, however, an optically pumped iodine laser has been demonstrated using a solar simulator. Solar pumping of bound-bound absorption transitions, typical of infrared lasers, is also a possibility. This approach normally would be very inefficient, and therefore of little interest, due to the fact that the absorption bandwidths of many potential gas laser media are small in relation to the effective bandwidths of the solar spectrum. Consequently, only a very small fraction of the solar energy can be absorbed and converted into laser light. A concept for efficient optical pumping of an infrared laser medium has evolved which has the potential of making these solar-pumped lasers very efficient. In this method, a blackbody heated by focused sunlight is used as the optical pumping source. The concept is described.

24712 (SERI/CP—252-2714, pp 51-62) **Pyroelectric conversion.** Olsen, R.B. (Chronos Research Labs., Inc., Olivenhein, CA). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

Pyroelectric conversion is the electrical analog of the steam engine. The thermodynamic variables charge and voltage are analogous to volume and pressure. Special (ferroelectric) materials show large couplings between thermal and electrical properties near their (ferroelectric to paraelectric) phase transitions. Ceramic pyroelectric converters have been demonstrated with efficiencies of about one tenth of the Carnot limit at 1.8 Watt power level. A recently discovered polymer promises a factor of 35 increase in the electrical output per unit volume over the older ceramic materials. In addition to low cost ($0.05/w), the new polymer is expected to permit operation at greater than half the Carnot limit. After the polymer properties are developed it is anticipated that complete pyroelectric conversion systems costing less than $1.00/w will convert 150°C heat (solar or industrial waste) into electricity at about 15% efficiency.

24713 (SERI/CP—252-2714, pp 65-79) **Solar thermal/electric conversion using the sodium heat engine.** Hunt, T.K. (Ford Motor Co., Dearborn, MI). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

The Sodium Heat Engine (SHE) is a high efficiency energy conversion device capable of the direct conversion of heat to electricity using thermal input at temperatures in the range from 700 to 1000°C. The SHE operates by extracting electrical energy from the electrochemical expansion of sodium vapor across a beta-alumina solid electrolyte (BASE) membrane. Because the efficiency of the SHE system should be essentially independent of size, it is anticipated that most systems will be constructed from modules of modest output, probably in the range from 1 to 10 kW. Experiments performed thus far suggest that efficiencies in the range from 25 to 35% will be possible in fully developed SHE systems. Modular system fabrication appears to offer a number of particular advantages for solar thermal conversion. The SHE system is described.

24714 (SERI/CP—252-2714, pp 79-109) **Solar thermionic energy conversion.** Lieb, D.; Miskolczy, G. (Thermo Electron Corp., Waltham, MA). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

Thermionic energy converters are simple and environmentally clean devices for converting heat to electricity. A metal electrode, the emitter, is heated until electrons boil from its surface. The emitted electrons cross a narrow interelectrode gap and condense on the collector. This flow of electrons constitutes an electric current that delivers power to a load. This concept is discussed. Research into this technology conducted over a number of years has led both to greatly increased understanding of the underlying physics of this phenomenon and to practical electricity-producing devices which proved themselves suitable for astronautical applications.

24715 (SERI/CP—252-2714, pp 111-132) **High temperature thermoelectric conversion.** Wood, C. (California Institute of Technology, Pasadena). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

An equation for the calculation of the maximum efficiency for the conversion of heat to electrical energy using a thermoelectric couple with a hot junction is presented and discussed. The application of this method to high-temperature thermoelectric energy conversion is described. One class of material receiving attention for high-temperature thermoelectric energy conversion is the rare earth chalcogenides. The properties of these materials are discussed.

24716 (SERI/CP—252-2714, pp 133-148) **Magnetic heat engines.** Kirol, L.D. (Idaho National Engineering Lab., Idaho Falls). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

Thermal energy counters magnetic order, so for a given applied magnetic field, magnetization decreases as temperature increases. This phenomena makes the operation of magnetic heat engines possible. Heat is converted into work via changes in entropy which occur upon magnetization; at any given temperature, entropy of magnetized material is less than the entropy of unmagnetized material. This is analogous to pressure changes of a gas; for any temperature, entropy of the gas decreases with increasing pressure. With magnetic cycles, applied magnetic field plays the role of pressure in reducing entropy. Change in entropy upon application of a magnetic field is maximum at the Curie temperature, as is the slope of the magnetization-temperature curve. Magnetic heat engines must be operated near the Curie temperature of the working material, but materials are available with virtually any Curie temperature to 1400 K. This concept is discussed.

24717 (SERI/CP—252-2714, pp 232-234) **Evaluation of direct energy conversion technologies for solar applications.** Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

An evaluation of various direct energy conversion technologies is presented. It was sought to determine the maturity of the technology as well as the characteristics of the technology that would affect its interface with the solar resource. The direct conversion technologies were ground into three categories of maturity: conceptual, which means the idea has not yet been proven feasible (although it may appear to have potential from a solar point of view); feasible, which means the idea has been proven with laboratory or bench scale demonstrations but insufficient data exists for a complete assessment; and operational, which means that prototypes of the idea have been built and sufficient data exists for a complete assessment.

24718 (SERI/SP—231-2550) **Fuels from microalgae: Technology status, potential, and research requirements.** Neenan, B.; Feinberg, D.; Hill, A.; McIntosh, R.; Terry, K. (Solar Energy Research Inst., Golden, CO (USA)). Aug 1986. Contract AC02-83CH10093. 171p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86010739.

Although numerous options for the production of fuels from microalgae have been proposed, our analysis indicates that only two qualify for extensive development - gasoline and ester fuel. In developing the comparisons that support this conclusion, we have identified the major areas of microalgae production and processing that require extensive development. Technology success requires developing and testing processes that fully utilize the polar and nonpolar lipids produced by microalgae. Process designs used in these analyses were derived from fragmented, preliminary laboratory data. These results must be substantiated and integrated processes proposed, tested, and refined to be able to evaluate the commercial feasibility from microalgae. The production of algal feedstocks for processing to gasoline or ester fuel requires algae of high productivity and high lipid content that efficiently utilize saline waters. Species screening and development suggest that algae can achieve required standards taken individually, but algae that can meet the integrated requirements still elude researchers. Effective development of fuels from microalgae technology requires that R and D be directed toward meeting the integrated standards set out in the analysis. As technology analysts, it is inappropriate for us to dictate how the R and D effort should proceed to meet these standards. We end our role by noting that alternative approaches to meeting the feasibility targets have been identified, and it is now the task of program managers and scientists to choose the appropriate approach to assure the greatest likelihood of realizing a commercially viable technology. 70 refs., 39 figs., 35 tabs.

24719 (SERI/SP—231-3071) **FY 1986 aquatic species program: Annual report.** (Solar Energy Research Inst., Golden, CO (USA)). Feb 1987. Contract AC02-83CH10093. 345p. NTIS MF A01; 2; GPO Dep. File Number DE87001149.

The goal of the Aquatic Species Program is to develop the technology to produce gasoline and diesel fuels from microalgae grown in saline waters of the desert Southwest. Three major task areas are important to the economical development of this technology: biology, engineering, and analysis. Biological activities include screening, characterizing, and improving microalgae species. More than 3000 microalgae strains have been collected to date. With the intensive collection efforts, the program now has strains that can tolerate wide environmental fluctuations, from 10° to 35°C and 10 to 70 mmho cm^{-1}. Rates of productivity increased from 10 to 20 g dry wt m^{-2} d^{-1} in 1982 to greater than 50 g dry wt m^{-2} d^{-1} under laboratory conditions and more than 35 g dry wt m^{-2} d^{-1} in outdoor systems in 1986. Lipid content of the algal cells also increased significantly. A current problem is that salinity- and temperature-tolerant species do not have high productivity and produce large amounts of lipid. Therefore, basic research is under way in genetic engineering to put all three characteristics into one or two strains. Engineering research focused on polymer harvesting of microalgae. Aggressive research is needed, but the improvements defined are within the bounds of attainability. A major concern has been the availability of saline water resources in the desert Southwest. It has been recently demonstrated, however, that there is sufficient saline water in Arizona and New Mexico to produce at least one quad of energy from microalgae.

24720 (TVA/ONRED/LER—87/10) **Directory of biomass installations in 13 southeastern states.** (Tennessee Valley Authority, Norris (USA). Div. of Land and Economic Resources). Dec 1986. Contract AI01-83CE30792. 557p. NTIS, PC A24/MF A01; 1; GPO Dep. File Number DE87007873.

Installations identified as biomass energy facilities are listed by state and installation type: alcohol (fuel), combustion, gasification, methane and fuel supplier; 1019 installations are represented. A description and the associated plant specifications are given where available. Reference is directed to SERIES-online, a database specifically designed to support communications, from which this directory was reproduced.

24721 **Time-dependent open-circuit voltage in $CuInSe_2$/CdS solar cells: Theory and experiment.** Ruberto, M.N.; Rothwarf, A. (Electrical and Computer Engineering Department, Drexel University, Philadelphia, Pennsylvania 19104). *Journal of Applied Physics;* **61**: No. 9, 4662-4669(1 May 1987).

The increase with illumination time of the open-circuit voltage of the $CuInSe_2$/CdS solar cell has been studied as a function of illumination intensity, temperature, and preillumination bias voltage. The results indicate time constants on the order of minutes (40 to 500 s at room temperature), with an activation energy of —0.20 eV. The magnitude of the effect (ΔV/sub oc/ ≦30 mV) and the time constants both decrease with increasing preillumination voltage bias, indicating that the effect is due to voltage rather than illumination. A model involving the tunneling of electrons trapped in deep states in the CdS, near the junction with the $CuInSe_2$ layer to holes in the $CuInSe_2$ valence band, seems to account for the magnitude, as well as the time and voltage dependence of the effect. The increased positive charge near the interface shifts the division of the diffusion voltage between the two sides of the junction, thereby increasing V/sub oc/. The fill factor and efficiency of the cell are also increased, while the short-circuit current is unaffected.

24722 **Semiconductor electrode with improved photostability characteristics.** Frank, A.J. (to Dept. of Energy, Washington, DC). US Patent 4,650,558. 17 Mar 1987. Filed date 19 Feb 1985. vp.

A photoelectrochemical cell is described for generating fuels and useful chemicals by certain chemical reactions, the photoelectrochemical cell comprising: a. an aqueous electrolyte including a least two different redox couples; and b. at least one photoelectrode, the photoelectrode comprising: (i) a semiconductor for producing photogenerated carriers; (ii) a charge conducting polymer film directly covering the semiconductor for substantially suppressing photodegradation of the semiconductor in the aqueous electrolyte resulting from a reaction of the photogenerated carriers with the semiconductor crystal lattice coupled with effects of solvation. The charge conducting polymer substantially suppresses the photodegradation by facilitating a transport of the photogenerated carriers from the semiconductor to the aqueous electrolyte so as to substantially prevent the photogenerated carriers from reacting with the semiconductors; (iii) a hydrophobic film covering with the charge conducting polymer for facilitating the suppressing of the photodegradation.

24723 Novel fermentation: the production of R(-)-1,2-propanediol and acetol by Clostridium thermosaccharolyticum. Cameron, D.C.; Cooney, C.L. (Massachusetts Institute of Technology, Cambridge). *Bio/Technology;* **4**: No. 7, 651-654(Jul 1986). Contract AC02-83CH10093.

Three strains of Clostridium thermosaccharolyticum were found that produce R(-)-1,2-propanediol from a variety of sugars, including D-glucose and D-xylose. The fermentation of glucose by strain HG-8 (ATCC 31960) gave 7.9 g/l of R(-)-1,2-propanediol with a best yield of 0.27 g/g glucose and an enantiomeric excess of greater than 99%. Acetol accumulated to 1.47 g/l. Product formation was not affected by phosphate concentrations up to 113 mM. A possible pathway to these products involves a variation of the methylglyoxal bypass. Methylglyoxal is reduced to acetol, which is further reduced to %(-)-1,2-propanediol. This fermentation provides a unique route to R(-)-1,2-propanediol and acetol from inexpensive, readily available substrates.

24724 Direct radiant heating of particle suspensions for the production of fuels and chemicals using concentrated sunlight. Hunt, A.J.; Ayer, J.; Hull, P.; Miller, F.; Russo, R.; Yuen, W. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 1947-1952 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—). Contract AC03-76SF00098.

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper describes recent advances in the research program at LBL to understand the behaviour of radiantly heated gas-particle suspensions. The research is investigating the use of gas-particle suspensions to absorb concentrated sunlight to supply energy for endothermic chemical reactions. The analytical section includes the description of a chemical survey, the results of optical calculations, and a summary of our heat transfer studies. The experimental section outlines the current laboratory studies of direct radiant heating that utilize a high intensity radiant source to simulate concentrated sunlight. This work is aimed at establishing a technology base supporting new applications of concentrated sunlight for the production of useful fuels and chemicals.

24725 Rapid polymer transport in concentrated solutions. Preston, B.N.; Comper, W.D. (Biochemistry Dept., Monash Univ., Clayton, Victoria). pp 105-152 of Solar energy: Phase transfer catalysis, transport processes. New York, NY; Springer-Verlag New York Inc. (1984).

This article discusses the rapid transport of polymers in terms of diffusional or diffusional-related processes. In particular it reviews: polymer and solvent diffusion in binary systems; polymer transport in ternary systems including an analysis of the cross diffusion coefficients and component distribution within the systems; macromolecular transport in transient polymeric networks and an introduction to the observation of rapid migration in such systems; detailed discussion of measurement of and factors involved in rapid polymer transport in multicomponent systems; identification of structured flow associated with rapid polymer transport and some simple mechanistic interpretations; and rapid polymer transport and model biological systems. The aim of the article is to introduce new observations of diffusive-convective phenomena in polymer chemistry. The processes discussed are of significance to those interested in transport phenomena.

24726 Solar energy conversion by functional polymers. Kaneko, M.; Yamada, A. (The Institute of Physical and Chemical Research, Wako-Shi, Saitama, 351). pp 1-48 of Solar energy: Phase transfer catalysis, transport processes. New York, NY; Springer-Verlag New York Inc. (1984).

To convert photoenergy chemically, a heterogeneous reaction system is needed to prevent energy-consuming back reactions. From that reason, the development of conversion systems composed of molecular assemblies or polymers has become an active center of research on solar energy conversion. The molecular assemblies such as micells, liposomes, or bilayer membranes provide microheterogeneous reaction environment, which facilitates one-directional electron flow. Macroheterogeneous conversion systems are constructed by utilizing polymers as solid phase supports or membranes. Polymer supported metal colloids and polynuclear metal complexes are the catalysts in water photolysis systems. Solar cells composed of polymer films are also important subjects. In this review article, the functions of polymers and molecular assemblies for solar energy conversion will be described including photochemical conversion models, elemental processes for the conversion such as charge separation, electron transfer, and catalysis for water decomposition, as well as solar cells.

1406 Photovoltaic Power Systems

REFER ALSO TO CITATION(S) 24739, 25278

24727 (N—87-15267) Electrical power system design for the US space station. Nored, D. L.; Bernatowicz, D. T. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Aug 1986. 19p. (NASA-TM—88824; E—3073; NAS—1.15:88824; CONF-860810—48). NTIS, PC A02/MF A01.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

The multipurpose, manned, permanent space station will be our next step toward utilization of space. A multikilowatt electrical power system will be critical to its success. The power systems for the space station manned core and platforms that have been selected in definition studies are described. The system selected for the platforms uses silicon arrays and Ni-H_2 batteries. The power system for the manned core is a hybrid employing arrays and batteries identical to those on the platform along with solar dynamic modules using either Brayton or organic Rankine engines. The power system requirements, candidate technologies, and configurations that were considered, and the basis for selection, are discussed.

24728 (N—87-15270) Space station experiment definition: advanced power system test bed. Final report. Pollard, H. E.; Neff, R. E. (Ford Aerospace and Communications Corp., Palo Alto, CA (USA)). Dec 1986. 148p. (NASA-CR—179502; NAS—1.26:179502; WDL—TR10939). NTIS, PC A07/MF A01.

A conceptual design for an advanced photovoltaic power system test bed was provided and the requirements for advanced photovoltaic power system experiments better defined. Results of this study will be used in the design efforts conducted in phase B and phase C/D of the space station program so that the test bed capabilities will be responsive to user needs. Critical PV and energy storage technologies were identified and inputs were received from the idustry (government and commercial, U.S. and international) which identified experimental requirements. These inputs were used to develop a number of different conceptual designs. Pros and cons of each were discussed and a strawman candidate identified. A preliminary evolutionary plan, which included necessary precursor activities, was established and cost estimates presented which would allow for a successful implementation to the space station in the 1994 time frame.

1407 Solar Thermal Power Systems

REFER ALSO TO CITATION(S) 24727, 25772

24729 **(DOE/JPL—1060-89) Summary assessment of solar thermal parabolic dish technology for electrical power generation.** Panda, P.L.; Fujita, T.; Lucas, J.W. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Sep 1985. Contract AI04-80AL13137. 124p. (JPL-PUB—85-55). NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87005428.

An assessment is provided of solar thermal parabolic dish technology for electrical power generation. The assessment is based on the development program undertaken by the Jet Propulsion Laboratory for the US Department of Energy and covers the period from the initiation of the program in 1976 through mid-1984. The program was founded on developing components and subsystems that are integrated into parabolic dish power modules for test and evaluation. The status of the project is summarized in terms of results obtained through testing of modules, and the implications of these findings are assessed in terms of techno-economic projections and market potential. The techno-economic projections are based on continuation of an evolutionary technological development program and are anchored to the accomplishments of the program as of mid-1984. The accomplishments of the development effort are summarized for each major subsystem including concentrators, receivers, and engines. The ramifications of these accomplishments are assessed in the context of developmental objectives and strategies.

24730 **(PNL—6128-Vol.1) Characterization of solar thermal concepts for electricity generation: Volume 1, Analyses and evaluation.** Williams, T.A.; Dirks, J.A.; Brown, D.R.; Drost, M.K.; Antoniac, Z.A.; Ross, B.A. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1987. Contract AC06-76RL01830. 219p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87007161.

This study is aimed at providing a relative comparison of the thermodynamic and economic performance in electric applications of several concepts that have been studied and developed in the DOE solar thermal program. Since the completion of earlier systems comparison studies in the late 1970's, there have been a number of years of progress in solar thermal technology. This progress has included development of new solar components, improvements in component and system design detail, construction of working systems, and collection of operating data on the systems. This study provides an updating of the expected performance and cost of the major components and the overall system energy cost for the concepts evaluated. The projections in this study are for the late 1990's time frame, based on the capabilities of the technologies that could be expected to be achieved with further technology development.

24731 **(SAND—86-0981) Evaluation of spherical ceramic particles for solar thermal transfer media.** Hellmann, J.R.; Eatough, M.O.; Hlava, P.F.; Mahoney, A.R. (Sandia National Labs., Albuquerque, NM (USA)). Jan 1987. Contract AC04-76DP00789. 61p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007432.

Two ceramic materials, spheroidized sintered bauxite and fused zircon, were evaluated for potential use as thermal transfer media in an advanced high temperature solid particle solar receiver. Both materials were sufficiently resistant to aggregation via sintering to permit repeated cycling of the particle charge to temperatures approaching 1400°C provided no pressure was applied to the particle bed. Application of pressure dramatically enhanced sintering above 1100°C and yielded non-flowable sintered particle masses. This indicates that moving particle bed storage configurations must be employed for temperatures in excess of 1100°C. The sintered bauxite material exhibited a higher solar absorptance (0.94) than the fused zircon (0.74) for all conditions investigated. Extended thermal treatments in air markedly degraded the solar absorptance of both materials. Degradation was attributed to modifications in crystalline phase assemblages and distribution of multivalent iron and titanium cations. High solar absorptances could be restored by reheating the "oxidized" specimens in mildly reducing atmospheres. Potential improvements in the solar absorptance of the fused zircon material may be possible through doping the material with higher concentrations of transition metal and rare earth cations.

24732 **Measurement of temperatures in fibrous insulators subjected to concentrated solar radiation.** Matthews, L.K.; Sierra, R.; Bergan, N. (New Mexico State Univ., Las Cruces). *Solar Energy;* **38**: No. 1, 1-7(1987).

Fibrous insulating materials, such as alumina-silica and zirconia, have been studied upon several occasions. In some of these studies attempts have been made to measure the temperature in the semitransparent materials subjected to concentrated sun light. This study was motivated by the need to estimate surface temperatures in the cavity of the Molten Salt Electric Experiment (MSEE) solar receiver tested at the Central Receiver Test Facility in Albuquerque, NM. In this experiment several type K (chromel-alumel) thermocouples were installed in the alumina-silica insulating materials lining the wall of the receiver cavity. These thermocouples were installed through the back of the insulation and shielded from transmitted and scattered solar radiation by using an alumina cement that was much more opaque to the incoming radiation from the surrounding material. Comparisons were made between shielded and nonshielded thermocouples at the New Mexico State University Solar Furnace. In addition, measurement errors introduced by installing the thermocouples from the back rather than from the side were studied. From these measurements comparisons were made with the computer code TOTAL which was then used to estimate the temperature distribution in the material used in the MSEE receiver.

24733 **Operational evaluation of the grid-connected Coolidge solar thermal electric power plant.** Larson, D.L. (Univ. of Arizona, Tucson). *Solar Energy;* **38**: No. 1, 11-24(1987).

Results of the operation and evaluation of the grid-connected Coolidge solar thermal-electric power plant are reported. Performance was determined for each of the major subsystems-line focus collector array, thermal energy storage and 200 kW organic fluid Rankine cycle engine and generator. Daily collector array efficiency (based on total direct solar radiation) was nominally 32% in June, 26% in September and 9% in December. Rankine cycle engine-generator conversion efficiency was about 20%; electrical parasitic losses reduced the efficiency by 12%. Operation and maintenance required about 90 h/mo, only 20% requiring special skills or training. Operating supplies and repair services cost about $6300 per year.

24734 **(ESA-TT—61) Measurement of radiation intensity at the solar tower plant SSPS/CRS of the IEA in Spain.** Brinner, A. (European Space Agency, 75 - Paris (France)). Jan 1986. Translated from Strahlungsintensitaets-Messung am Solarturmkraftwerk SSPS/CRS der IEA in Spanien Stuttgart, West Germany. (DFVLR-FB—85-36; ETN—86-98246). 42p. NTIS, PC A03/MF A01; original German version avail. at DFVLR, Cologne, West Germany DM 15.

The Kendall MK9 radiometer was selected to measure the radiation intensity on the IEA SSPS/CRS solar tower plant in Spain. The measuring signal was applied to calibrate a video camera used for measurement of power density distribution in the aperture of the solar absorber. The measurement results were used to show a relationship between the gray values of a video picture of the ASR receiver under radiation and the absolute radiation intensity measured at three points so as to calculate the absolute irradiation in MW. The tests show good reproducibility and high accuracy. The conversion factors were applied to calculate the flux distribution, the maximum flux and the ASR receiver efficiency.

24735 **Film stability for direct absorption receivers.** Wang, K.Y.; Newell, T.A.; Copeland, R.J. (Solar Energy Research Institute, Golden, CO 80401). pp 1462-1466 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The direct absorption receiver (DAR) concept offers the potential of high temperature operation by using concentrated solar energy. This paper examines the minimum flow rate and other relevant issues required to maintain a continuous film flowing over the absorption surface.

24736 **Performance and operating experience of the Solar Total Energy Project at Shenandoah, Georgia.** Stine, W.B.; Ney, E.J.; Heckes, A.A.; Connolly, J.M. (California State Polytechnic Univ., Pomona, CA 91768). pp 1398-1402 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper presents the results from 29 operational experiments evaluating the performance of the U.S. Department of Energy sponsored Solar Total Energy Project (STEP) at Shenandoah, Georgia. The experiments were conducted during March through December 1984. They were performed under varying insolation conditions using solar-only, fossil-only, and hybrid energy sources, with different electrical and thermal loads and at different electrical load configurations (constant power, sun-following, load-following, and peak-shaving). Three typical experiments are discussed, and energy flow diagrams are presented which show that cogeneration significantly increases the utilization of solar thermal power. An annualized projection, using a computer model of the system, shows that a solar system can efficiently provide electrical power, process steam, and absorption air conditioning to an industrial host.

1408 Ocean Energy Systems

24737 **(PB—87-146833/XAB) Potential impact of ocean thermal energy conversion (OTEC) on fisheries. Technical report.** Myers, E.P.; Hoss, D.E.; Matsumoto, W.M.; Peters, D.S.; Seki, M.P. (National Marine Fisheries Service, Washington, DC (USA)). Jun 1986. 41p. (NOAA-TR-NMFS—40). NTIS, PC A03/MF A01.

The commercial development of ocean thermal energy conversion (OTEC) operations will involve some environmental perturbations for which there is no precedent experience. The pumping of very large volumes of warm surface water and cold deep water and its subsequent discharge will result in the impingement, entrainment, and redistribution of biota. Additional stresses to biota will be caused by biocide usage and temperature depressions. However, the artificial upwelling of nutrients associated with the pumping of cold deep water, and the artificial reef created by an OTEC plant may have positive effects on the local environment. Although more detailed information is needed to assess the net effect of an OTEC operation on fisheries, certain assumptions and calculations are made, supporting the conclusion that the potential risk to fisheries is not significant enough to deter the early development of OTEC. It will be necessary to monitor a commercial-scale plant in order to remove many of the remaining uncertainties.

1409 Solar Thermal Utilization

REFER ALSO TO CITATION(S) 24743, 24744, 25043, 25046, 25056, 25109

24738 **(DOE/CE/30828—T1) An assessment of the DOE Active Solar Planning Process: Final report.** (ACEC Research and Management Foundation, Washington, DC (USA)). Mar 1985. Contract FG01-84CE30828. 109p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007597.

This report is a review of the planning process used by the Active Solar Heating and Cooling Program, Office of Solar Heat Technologies, US Department of Energy as it pertains to a project title, "An Industry Assessment of Solar Building R and D Needs." This report will restrict its discussion to the active solar planning aspects of this particular project, and will not address Congressional plans for funding the DOE solar programs, DOE national laboratory planning procedures, internal DOE programmatic directives and procedures, or planning activities provided by DOE support services contractors. The purpose of the DOE planning process is to establish a systemmatic procedure for developing a future program of activities. The DOE procedure is designed to include an assessment of current goals and objectives, review direction of the overall program, and appraise present program activities to assure they are in tune with the public interest and private sector needs. This project was designed to provide broad private sector input to the process.

24739 **(PB—87-139549/XAB) Final solar-systems monitoring report, 1985.** (Ontario Ministry of Energy, Toronto (Canada)). 1985. 217p. NTIS, PC PC E08/MF E01.

The Active Solar Monitoring Project was conducted by the Ministry of Energy of the Province of Ontario, Canada, between November, 1982, and October, 1985. The objective of the project was to instrument, monitor, assess, and report on the energy performance and reliability of the solar energy demonstration projects sponsored by the Ministry. The monitoring project was an essential part of Ontario's Solar Energy Program, which included over 190 solar-heating demonstration projects, and 2 photovoltaic demonstration projects. These were located on government buildings, and on commercial, industrial, municipal, institutional, and religious buildings. The solar energy systems on some of these buildings, and their monitoring activities, were sponsored jointly by the Ministry of Energy, and Energy Mines, and Resources Canada.

24740 **Solar solids reactor.** Yudow, B.D. (to Dept. of Energy). US Patent Patent Application 6-832,617. 24 Feb 1986. 15p. Contract AC03-82SF11662. DE87007300 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007300.

A solar powered kiln is provided, that is of relatively simple design and which efficiently uses solar energy. The kiln or solids reactor includes a stationary chamber with a rearward end which receives solid material to be reacted and a forward end through which reacted material is disposed of, and a screw conveyor extending along the bottom of the chamber for slowly advancing the material between the chamber ends. Concentrated solar energy is directed to an aperture at the forward end of the chamber to heat the solid material moving along the bottom of the chamber. The solar energy can be reflected from a mirror facing at an upward incline, through the aperture and against a heat-absorbing material near the top of the chamber, which moves towards the rear of the chamber to distribute heat throughout the chamber. Pumps at the forward and rearward ends of the chamber pump heated sweep gas through the length of the chamber, while minimizing the flow of gas through an open aperture through which concentrated sunlight is received.

24741 **Conservation and solar guidelines.** Balcomb, J.D. (Los Alamos National Lab., Los Alamos, NM 87545). *Passive Solar Journal;* 3: No. 3, 221-248(1986).

Guidelines are given for selecting R-values and infiltration levels, and determining the size of the solar collection area for passive solar buildings. The guidelines are based on balancing the incremental cost/benefit of conservation and passive solar strategies. Tables are given for 90 cities in the United States and the results are also displayed on maps. The procedures are developed in an appendix, which gives the cost assumptions used and explains how to develop different guidelines for different costs.

1410 Solar Collectors And Concentrators

REFER ALSO TO CITATION(S) 24730

24742 **Liquid cooled fiber thermal radiation receiver.** Butler, B.L. (to Dept. of Energy, Washington, DC). US Patent 4,643,168. 17 Feb 1987. Filed date 29 Mar 1985. vp.

This patent describes a solar energy absorbing thermal receiver apparatus of rectangular elongate orientation maintained by a support stand and having inlet and outlet ports on opposite ends thereof. The receiver includes a support plate having bores for transmitting thermal energy, the receiver adapted to operate within a temperature range of 100°-1200°C. and at a 10 sun or greater solar energy density; the thermal receiver comprising: an array of blackened, closely-spaced, small-diameter fibers for capturing incident solar radiation striking a side of the receiver. The array has an orientation adapted to govern the absorption of solar energy by the receiver, the array having a predetermined configuration and density; a transparent molten salt for collecting incident solar radiation captured by the fibers, the collecting action adapted to cool the fibers as solar energy is removed, the molten salt having a low vapor pressure; and means for transferring the solar energy disposed within the salt to the outlet port, the direction thereof being through the array of fibers and the bores disposed within the support plate to the outlet port.

24743 **Solar pond heat removal using a submerged heat exchanger.** Hull, J.R.; Scranton, A.B.; Kasza, K.E. (Argonne National Lab., Argonne, IL 60439). pp 1505-1509 of Proceedings of the ninth biennial congress of the International Solar Energy Society. Bilgen, E.; Hollands, K.G.T. Elmsford, NY; Pergamon Books Inc. (1985). (CONF-850604—). Contract W-31-109-ENG-38.

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The results of operating a submerged plastic-tube heat exchanger in the 1080 m/sup 2/ Research Salt Gradient Solar Pond at Argonne National Laboratory are presented. The heat exchange system simulates grain drying, in which the temperature of the ambient air is raised 8-15°C when it passes through a liquid-to-air heat exchanger that is coupled to the submerged heat exchanger. Approximately 1.0 x 10/sup 11/ J (100 MMBtu) were extracted from the pond, and the operation had no adverse effects on the stability of the salt gradient.

1420 Heat Storage

24744 **(ORNL—6281) Design of PCM enhanced passive solar structures.** Drake, J.B.; Geist, G.A.; Morris, M.D.; Solomon, A.D.; Martin, J.F.; Tomlinson, J.J. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007785.

A design methodology for a passive solar structure using phase change materials for thermal storage is presented. The discussion focuses on the use of PCM's, charged by direct illumination of the sun. The interaction and importance of design elements are presented. The effect of material properties on the performance of a solar structure is studied using a computer simulation of the structure for a heating season. The computed results indicate the importance of the choice of the transition temperature. An analytic expression approximating the computed results shows the effect of variation of the density and latent heat on the performance of the PCM as a thermal storage medium in the solar structure.

24745 **Chemical storage of solar energy - kinetics of heterogeneous NH_3 and H_2SO_4 reactions. II. Process and reactor design.** Ranade, S.M.; Lee, M.C.; Prengle, H.W. Jr. (Univ. of Houston, TX). *Solar Energy;* **37**: No. 5, 375-388(1986).

An important energy recovery step in the ammonium hydrogen sulfate (AHS) cycle is the recombination reaction producing NH_4HSO_4. It has been determined that the optimum way to accomplish this, and prevent side reactions, is by the heterogeneous gas-liquid reaction of H_2SO_4 and NH_3. A mathematical model is presented and applied to the two reaction zones and a method of numerical solution is discussed. Three horizontal pilot-scale configurations, 0.17 x 10^6 to 4.2 x 10^6 kJ/h energy release, are discussed and sizing is presented. The most important conclusion from the work is that the energy can be released most effectively by carrying out the reaction in a double pipe tubular reactor operating in the annular flow regime with both gas and liquid in turbulent flow.

15 GEOTHERMAL ENERGY

1501 Resource Status And Assessment

24746 **(BGS-GPB—7006) Eastern Highlands granites: heat flow, heat production and model studies. Investigation of the geothermal potential of the UK.** Wheildon, J.; King, G.; Crook, C.N.; Thomas-Betts, A. (British Geological Survey, Keyworth. Geothermal Resources Programme; Natural Environment Research Council, London (UK)). 1984. 40p. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

The hot dry rock geothermal potential of selected Caledonian granites was investigated. Four new heat flow values reported include 70, mWm^{-2} for the Cairngorm Granite, 59 mWm^{-2} for the Mount Battock Granite, 71 mWm^{-2} for the Ballater Granite and 76 mWm^{-2} for the Bennachie Granite, and corresponding preferred surface heat production values are respectively 7.3, 4.8, 6.8 and 7.0 μWm^{-3}. Finite element models have been set up. Reconciliation of the high surface heat production and only moderately elevated heat flow by assuming a much more rapid decrease in heat production with depth than has been inferred elsewhere in the UK is reported. Predicted sub-surface temperatures averaging 45°C at 2 km and 105°C at 6 km eliminate the Eastern Highlands as a potential hot dry rock prospect.

1502 Geology And Hydrology Of Geothermal Systems

REFER ALSO TO CITATION(S) 26004

24747 **(LBL—22852) Proceedings of the second workshop on hydrologic and geochemical monitoring in the Long Valley Caldera.** Sorey, M.L.; Farrar, C.D.; Wollenberg, H.A. (eds.). (Lawrence Berkeley Lab., CA (USA)). Dec 1986. Contract AC03-76SF00098. 83p. (CONF-860788—Absts.). NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007885.

From 2. workshop on hydrologic and geochemical monitoring of Long Valley caldera; Mammoth Lakes, CA, USA (15 Jul 1986).

A workshop was held to review the results of hydrologic and geochemical monitoring and scientific drilling in the Long Valley caldera. Such monitoring is being done to detect changes in the hydrothermal system induced by ongoing magmatic and techonic processes. Data from a 2400-ft deep core hole completed in June 1986 were presented at the 1986 workshop and participants discussed the need and rationale for siting locations for future scientific drilling in the caldera.

24748 **(LBL—23115) Conceptual model of the Klamath Falls, Oregon geothermal area.** Prucha, R.H.; Benson, S.M.; Witherspoon, P.A. (Lawrence Berkeley Lab., CA (USA)). Jan 1987. Contract AC03-76SF00098. 14p. (CONF-870136—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008232.

From 12. workshop on geothermal reservoir engineering; Stanford, CA, USA (20 Jan 1987).

Over the last 50 years significant amounts of data have been obtained from the Klamath Falls geothermal resource. To date, the complexity of the system has stymied researchers, leading to the development of only very generalized hydrogeologic and geothermal models of the area. Recently, the large quantity of available temperature data have been re-evaluated, revealing new information on subsurface heat flow and locations of faults in the system. These inferences are supported by borehole, geochemical, geophysical, and hydrologic data. Based on re-evaluation of all available data, a detailed conceptual model for the Klamath Falls geothermal resource is proposed.

1503 Geothermal Exploration And Exploration Technology

REFER ALSO TO CITATION(S) 24746

1505 Economic And Financial Aspects

REFER ALSO TO CITATION(S) 24890

1506 Environmental Aspects And Waste Disposal

REFER ALSO TO CITATION(S) 24751

24740 (LBL—23022) Analysis of thermally induced permeability enhancement in geothermal injection wells. Benson, S.M.; Daggett, J.S.; Iglesias, E.; Arellano, V.; Ortiz-Ramirez, J. (Lawrence Berkeley Lab., CA (USA); Instituto de Investigaciones Electricas, Cuernavaca (Mexico)). Feb 1987. Contract AC03-76SF00098. 12p. (CONF-870136—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007613.

From 12. workshop on geothermal reservoir engineering; Stanford, CA, USA (20 Jan 1987).

Reinjection of spent geothermal brine is a common means of disposing of geothermal effluents and maintaining reservoir pressures. Contrary to the predictions of two-fluid models (two-viscosity) of nonisothermal injection, an increase of injectivity, with continued injection, is often observed. Injectivity enhancement and thermally-affected pressure transients are particularly apparent in short-term injection tests at the Los Azufres Geothermal Field, Mexico. During an injection test, it is not uncommon to observe that after an initial pressure increase, the pressure decreases with time. As this typically occurs far below the pressure at which hydraulic fracturing is expected, some other mechanism for increasing the near-bore permeability must explain the observed behavior. This paper focuses on calculating the magnitude of the nearbore permeability changes observed in several nonisothermal injection tests conducted at the Los Azufres Geothermal Field.

1509 Geothermal Engineering

REFER ALSO TO CITATION(S) 24749

24750 (LBL—22987) Decline curve analysis of production data from The Geysers geothermal field. Ripperda, M.; Bodvarsson, G.S. (Lawrence Berkeley Lab., CA (USA)). Jan 1987. Contract AC03-76SF00098. 8p. (CONF-870136—7). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007614.

From 12. workshop on geothermal reservoir engineering; Stanford, CA, USA (20 Jan 1987).

Production data for over two hundred wells at The Geysers geothermal field were compiled and analyzed. Decline curves for groups of wells with 5, 10, and 40 acre spacing are presented and compared to curves published previously by Budd (1972) and Dykstra (1981). Decline curves for several individual wells and leases are discussed to illustrate the effects of well spacing and location, as well as the heterogeneous nature of the reservoir.

1520 Geothermal Data And Theory

24751 (EPRI-AP—5111) A theory on mercury in geothermal fluids: Final report. Cobble, J.W. (Cobble (James W.), La Jolla, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 72p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920345.

A chemical equilibrium model has been developed for estimating the transport of mercury along geothermal fluid flow streams as they pertain to energy recovery and conversion from liquid-dominated geothermal reservoirs. The model shows that hydrogen and hydrogen sulfide concentrations and solid mercuric sulfide (cinnibar) control the dissolved and vapor equilibria throughout the system. Higher H_2S contents reduce soluble mercury in the brine. A number of gaseous mercury species which might vaporize into the steam were examined, including Hg, HgS, $(CH_3)_2Hg$, $HgCl_2$, and HgCl. Mercury vapor and gaseous HgS appear to be the only significant contributors to mercury volatility. Mercury concentrations and release rates have been calculated at a number of locations in a hypothetical geothermal system, including the wellhead, separator, turbine, non-condensable gas ejector, and cooling tower. The release rates to the environment will depend heavily on the H_2S/H_2 ratio at various locations in the plant and whether solid mercuric sulfide precipitated in the well casing is carried into the separator. Most of the volatile mercury will travel with the non-condensable gases.

17 WIND ENERGY

1701 Availability (climatology)

REFER ALSO TO CITATION(S) 24694

24752 (EPRI-AP—4794) Proceedings: Workshop on prospects and requirements for geographic expansion of wind power usage. Steitz, P. (Steitz and Associates, Sun Prairie, WI (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Nov 1986. Contract AC02-83CH10093. 64p. (CONF-8603171—Summ.). NTIS, PC A04/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1; GPO Dep. File Number DE87004104.

From Workshop on the prospects and requirements for geographic expansion of wind power usage; Dallas, TX, USA (5 Mar 1986).

This report constitutes the proceedings of a workshop on the Prospects and Requirements for Geographic Expansion of Wind Power Usage held March 5-6, 1986, in Dallas, Texas. The workshop was sponsored by the Electric Power Research Institute (EPRI) in cooperation with the Solar Energy Research Institute (SERI). SERI is operated by Midwest Research Institute for the US Department of Energy. The workshop participants concluded that there are a number of areas in the United States with substantial wind resources. Determining the potential for development of these resources for wind power will require local, detailed wind measurements. The participants saw no technology barriers to more widespread usage of wind power. They considered the greatest potential for advancement of wind power technology to be in the application of power electronics to enable variable speed wind turbine operation and to integrate and improve wind power station control and protection. Although wind power stations were seen as posing no health hazards, public and utility acceptance of the technology, the participants agreed, will require strong educational activities in all aspects of wind power. The implications of these conclusions for the research programs of EPRI and other sectors are discussed.

24753 (PNL—6105) A preliminary evaluation of the performance of wind tunnel and numerical modeling simulations of the wind flow over a wind farm. Barnard, J.C.; Wegley, H.L. (Pacific Northwest Lab., Richland, WA (USA)). Jan 1987. Contract AC06-76RL01830. 30p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87004634.

This report is an analysis of physical and numerical model simulations of the wind flow over complex terrain. The specific area to which these models were applied is a wind farm in the Altamont Pass area of California. The physical model results were obtained from wind tunnel flow simulations, and the numerical model used was the optimizing version of the NOABL model. The goals of this analysis were (1) to evaluate the relative performance of the two models and (2) to uncover any clues that would point toward improvement of the wind tunnel modeling. The performances of the models were gauged by comparing model simulations to wind observations taken over the modeled area.

1706 Wind Energy Engineering

24754 **(DOE/CE/15279—T2) Build, install and demonstrate a variable stroke pump control and windmill system: 2nd quarterly technical progress report.** (AV-YO, Inc., Kaneohe, HI (USA)). 30 Dec 1986. Contract FG01-86CE15279. 16p. NTIS, PC A02. File Number DE87003359.

Most of the time during the second quarter has been spent on the new gear drive. At the end of the 1st quarter the VSM (Variable Stroke Mechanism) was approximately 50% complete. Some work was done the second quarter on the VSM. An all steel mount was nearly completed for the hydraulic cyclinder. The purchased parts to finish the plumbing are on hand, the feedback control chain purchased, and one of the two pulleys was made. A safety device, that could be optional, is being designed and constructed. This addition would prevent damage to the equipment if all of the hydraulic fluid were lost for some reason.

24755 **(DOE/CH/10093—3) Wind energy systems: Program summary, Fiscal year 1984 and 1985.** (Solar Energy Research Inst., Golden, CO (USA)). Dec 1986. Contract AC02-83CH10093. 135p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87001109.

This document summarizes the research and development activities sponsored by the Wind/Ocean Technologies Division of DOE during fiscal years (FY) 1984 and 1985. The summary is organized into the following sections: an introduction to the Federal Wind Energy Program, its history, and current research directions; the program's organization for FY 1984 and FY 1985; the program's budget; highlighted accomplishments of the DOE field laboratories in FY 1984 and FY 1985; the program's future role; an index to and summaries of individual projects and contracts managed by each laboratory; and a bibliography of major publications produced by DOE and its laboratories in FY 1984 and FY 1985.

24756 **(DOE/NASA—0006-3) Design and dynamic simulation of a fixed pitch 56 kW wind turbine drive train with a continuously variable transmission.** Gallo, C.; Kasuba, R.; Pintz, A.; Spring, J. (Cleveland State Univ., OH (USA); National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Mar 1986. Contract AI01-76ET20320. 44p. (NASA-CR—179543). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006958.

This report covers the dynamic analysis of a horizontal axis fixed pitch wind turbine generator (WTG) that is rated at 56 kW. A mechanical Continuously Variable Transmission (CVT) was incorporated in the drive train to provide variable speed operation capability. One goal of the dynamic analysis was to determine if variable speed operation, by means of a mechanical CVT, is capable of capturing the transient power in the WTG/wind environment. Another goal was to determine the extent of power regulation possible with CVT operation.

24757 **(ECN—86-162) Influence of load management on the use of wind energy: the case of a wood processing factory.** Curvers, A.; Schuurman, J.J. (Netherlands Energy Research Foundation, Petten). Nov 1986. 8p. (CONF-870213—1). ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

From 6. American Society of Mechanical Engineers wind energy symposium; Dallas, TX, USA (15 Feb 1987).

Within the framework of the Dutch National Wind Energy Development Program projects have been set up to investigate the technical and economical feasibility of promising decentralized applications of wind energy. One of these projects concerns a grid connected wind turbine installed at a wood processing factory. During daytime the wind energy produced is used to power the wood processing machinery. During evening and night time the energy is used to charge batteries of fifteen electrical transport vehicles. A load management system has been installed to charge the batteries by preference with wind energy. During a period of two years (June 1984-June 1986) a measurement program has been carried out by the Netherlands Energy Research Foundation ECN in order to investigate the possibility of increasing direct use of wind energy with load management. It has been measured that the direct use of wind energy in this application amounted 76.2%. The direct use of the battery charging station is 29.4% and the increase that has been measured due to the load management system is less than 2%. This means that a load management system, as applied in this project, cannot improve the direct use of wind energy, mainly because the periods in which the load management system is used every day, is too short. 8 figs., 4 tabs., 4 refs.

24758 **(ECN—86-164) Phatas-1; program for horizontal axis wind turbine analysis and simulation. Volume 1. Model description.** Jehee, J.N.; Snel, H. (Netherlands Energy Research Foundation, Petten). Nov 1986. 83p. ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

The computer program for horizontal axis wind turbine analysis and simulation (PHATAS) aims to evaluate time responses of turbines which experience specified wind speeds and control strategies. These evaluations primarily yield the mechanical and aerodynamic loads on the rotor, the performance of the turbine and of the turbine control. Chapter 2 gives a conceptual description of the models used in PHATAS-1. Next, chapter 3 details the input needed for the geometry of the system, and the different wind models that can be used in the program. The following chapters give a more detailed and mathematical discussion of the aerodynamic theories involved (chapter 4), of the kinematical description of a moving turbine (chapter 5), the manner in which aerodynamic and mass loads are calculated (chapter 6) and finally of the resulting equations and their solution (chapter 7). The development of the PHATAS program was sponsored by the Netherlands Management Agency for Energy Research (PEO) as part of the National Program Plan on Wind Energy (NDW). 15 figs., 24 refs.

24759 **(ECN—87-010) The Netherlands large scale wind energy activities. Contribution to the IEA LS WECS. Annual report 1986.** Beurskens, H.J. (Netherlands Energy Research Foundation, Petten). Jan 1987. 15p. ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

The Dutch National Program Plan on Wind Energy launched by the Ministry of Economic Affairs in 1986 will cover the period 1986-1990. Available budgets for the three sub-programs: market development, industrial R and D, and general R and D, are Dfl. 68.5 million, Dfl. 37.0 million, and Dfl. 21.0 million, respectively. An overview of the large scale wind energy projects is given. It concerns wind turbines having 25 m, 26.5 m (3 x), 30 m (18 x), and 45 m rotor diameters. 5 figs., 7 tabs.

24760 **(RISO-M—2582) Wind conditions in wind turbine clusters.** Katic, I. (Risoe National Lab., Roskilde (Denmark)). Nov 1986. 39p. (In Danish). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751684.

A review of previous work on wind turbine clusters is given. Different "single-wake" models for calculation of turbine interaction is compared and their applicability for practical wind farm planning is evaluated. Results from windtunnel measurements on clusters and fullscale measurements on single turbines is presented and compared with model predictions. The greatest importance is attached to the reduced wind speed but also the increase of turbulence is considered. Finally a program, recently developed at Risoe for wind farm planning, is presented.

24761 **(SAND—86-1222C) Sandia National Laboratories 34-meter diameter vertical axis wind turbine test bed.** Klimas, P.C. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 5p. (CONF-870307—16). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003096.

From ASME/JSME/ISES solar energy conference; Honolulu, HI, USA (22 Mar 1987).

Sandia National Laboratories has designed, procured, and is erecting a 34-meter diameter vertical axis wind turbine test bed. The turbine incorporates many innovative features to investigate possible reductions in the cost-of-energy produced by wind energy conversion systems. These features include: blade element airfoil sections designed specifically for wind turbines, variable chord-variable section modular blades, stress reducing discontinuous slope blades, and variable speed-constant frequency generation capabilities. The modular blades allow for relatively simple partial configurational changes. Based on Sandia's twelve years of wind turbine research and testing, the test bed is heavily instrumented. The data acquisition and analysis system is capable of rapidly treating large amounts of information on both attended and unattended bases. A comprehensive test plan has been formulated. The turbine is intended to be the primary Department of Energy vehicle for validating concepts intended to improve vertical axis wind energy conversion systems.

24762 (SAND—86-1322C) **Structural design and fabrication of the Sandia 34-meter Vertical Axis Wind Turbine.** Ashwill, T.D. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 7p. (CONF-870307—7). NTIS MF A01; 2; GPO Dep. File Number DE87003503.

From ASME/JSME/ISES solar energy conference; Honolulu, HI, USA (22 Mar 1987).

The Wind Energy Research Division of Sandia National Laboratories has been funded by the Wind/Ocean Technology Division of the Department of Energy (DOE) to design and build a 34-meter diameter Vertical Axis Wind Turbine (VAWT). The turbine design incorporates the results of recent VAWT research in aerodynamics and structural dynamics. Initial system concept studies identified several blade options that met the required power rating of 500 kW. The final blade and rotor configurations were chosen based on finite element calculations that determined the turbine modes of response, their frequency of vibration, and stress levels. For parked survival turbine components were designed to with stand the loading of a 150 mph (67.0 m/s) wind coupled with maximum cable tensions. Specific areas of design discussed include the rotor, cables, bearings, brakes, and foundations. Construction of the turbine is in progress at this time and anticipated completion of the project is late spring of 1987.

24763 (SAND—86-1623) **Test plan for the 34 meter vertical axis wind turbine test bed located at Bushland, Texas.** Stephenson, W.A. (Sandia National Labs., Albuquerque, NM (USA)). Dec 1986. Contract AC04-76DP00789. 75p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87004777.

A plan is presented for the testing and evaluation of a new 500 kw vertical axis wind turbine test bed. The plan starts with the initial measurements made during construction, proceeds through evaluation of the design, the development of control methods, and finally to the test bed phase where new concepts are evaluated and in-depth studies are performed.

24764 (SAND—87-0214C) **The status of the vertical axis wind turbine research test bed.** Dodd, H.M. Jr. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 15p. (CONF-870477—1). NTIS, PC A02. File Number DE87005524.

From Energy technology conference; Albuquerque, NM, USA (15 Apr 1987).

The Sandia National Laboratories has designed, procured, and is presently erecting in Bushland, Texas, a Vertical Axis Wind Turbine (VAWT) research Test Bed in order to develop and demonstrate the improved technologies necessary for the next generation of commercial VAWTs. Of particular interest are the significant improvements predicted by analytical models in the areas of aerodynamic performance, structural dynamics, fatigue life and control strategies. The Test Bed is specifically designed to be a modular research tool rather than a commercial prototype unit; however, the research seeks to directly impact the cost of energy through increased energy capture, more efficient structures (i.e., lower initial cost), increased component lifetimes and improved operating procedures. As is befitting research hardware, the Test Bed is heavily instrumented in order to precisely define its performance and to accurately record the impact of various hardware and operational changes.

24765 (SERI/STR—217-3002) **Analysis and test results for an improved constant speed passive cyclic pitch wind turbine: Final subcontract report.** Hohenemser, K.H. (Washington Univ., St. Louis, MO (USA). Dept. of Mechanical Engineering; Solar Energy Research Inst., Golden, CO (USA)). Jan 1987. Contract AC02-83CH10093. 62p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001135.

This report describes research conducted at Washington University to address whether or not conventional blade-pitch control of wind turbines can be replaced by rotor yaw control. The test equipment consisted of a horizontal-axis wind turbine, mounted on a 60-ft tower, with an upwind, vane-controlled, passive-cyclic-pitch (PCP) rotor 25 ft in diameter. The automatic rotor-control system was passive. Some erratic yawing at low-speed, power-on operation was corrected with a larger-area tail vane and a longer tail boom. The turbine was tested at gusts of up to 60 mph. The power-off rotor speed was always kept fairly constant. The results would indicate smooth low-load storm survival. Generator cut-in and cut-out were achieved with a digital controller responding to rotor speed. Torque was found to peak at twice the value predicted by the conventional prop code. Overall, the PCP rotor continued to function very well, even at high yaw rates and wind velocities. However, the combination of the passive furl control system and a fast-reacting, wind-following tail vane caused some problems that could not be corrected at the time.

24766 (SERI/STR—217-3050) **The TEETER program: Analysis and user's guide: Final subcontract report, November 1, 1985.** Hansen, A.C. (Utah Univ., Salt Lake City (USA). Dept. of Mechanical and Industrial Engineering; Solar Energy Research Inst., Golden, CO (USA)). Jan 1987. Contract AC02-83CH10093. 56p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87001139.

This report documents and describes a single degree of freedom computer model for predicting the teetering motion of a two-bladed wind turbine rotor with a teetering hub. The model is intended for use by designers in selecting "worst case" design conditions and in determining sensitivity of teetering motion to the wide variety of machine and wind characteristics which must be considered. It is a relatively simple method requiring minimal computing hardware and negligible computing time or cost. Thus, it is well suited to rapid design trade-off studies and point design calculations. Details of the model and a comparison of some predicted and measured teetering motions are presented. Complete Fortran 77 listing and user's guide are included.

24767 (SERI/TP—217-3070) **A comparison of predicted wind turbine blade loads to test measurements.** Wright, A.D.; Thresher, R.W. (Solar Energy Research Inst., Golden, CO (USA)). Jan 1987. Contract AC02-83CH10093. 10p. (CONF-870307—9). NTIS, PC A02. File Number DE87001130.

From ASME/JSME/ISES solar energy conference; Honolulu, HI, USA (22 Mar 1987).

The accurate prediction of wind turbine blade loads and response is important in predicting the fatigue life of wind machines. At the SERI Wind Energy Research Center, a rotor code called FLAP (Force and Loads Analysis Program) is currently being validated by comparing predicted results to machine measurements. The FLAP code has been modified to allow the teetering degrees of freedom. This paper describes these modifications and comparisons of predicted blade bending moments to test measurements. Wind tunnel data for a 1/20th scale model will be used to compare FLAP predictions for the cyclic flap-bending moments at the 33% spanwise station for three different wind speeds. The comparisons will be made for both rigid and teetering hubs. Currently, the FLAP code accounts for deterministic excitations such as wind shear, tower shadow, gravity, and prescribed yawing motions. Conclusions will be made regarding the code's accuracy in predicting the cyclic bending moments.

20 ELECTRIC POWER ENGINEERING

24768 (DOE/RA/50659—T1) **Computer aided restoration of the large electric power system: Final report.** (Washington Univ., St. Louis, MO (USA). Dept. of Systems Science and Mathematics). 1984. Contract AC01-81RA50659. 182p. NTIS, PC A09. File Number DE87007755.

Objective is to develop a computer-aided procedure for restoring loads, generation and other equipment for largest cumulative priority as fast as possible on a failed electric power system, where some islands are operating and strong while others are weak or blacked out. This report discusses the restoration plan, database, establishing the plan, and implementing it. (DLC)

24769 **(TVA/OP/OPS—87/1) Turkish Electricity Authority Power System Rehabilitation Project: US facilities and capabilities orientation visit: Program report.** (Tennessee Valley Authority, Chattanooga (USA). Office of Power). 1987. 184p. NTIS MF A01. File Number DE87900623.

At the request of the United States Trade and Development program and in partnership with the US private engineering, construction and equipment sector, the Tennessee Valley Authority hosted four TEK technical experts from July 12 to August 2, 1986. Purpose of the delegation's visit was to examine a wide range of power-facilities used in this country and to become familiar with the associated capabilities of the US electric utility industry. Of specific interest to the delegates was information about the industry's capabilities in regard to the rehabilitation of power system facilities. The visitation program was organized to provide exposure to a representative sampling of the generation, transmission, and distribution components of a typical American power system and to give coverage to many of the standard principles and practices involved in the design, operation, and maintenance of each of these power components and the management of the system as a whole.

2001 Power Plants And Power Generation

REFER ALSO TO CITATION(S) 24870

24770 **(EPRI-AP—5098-SR) Workshop on retrofit controls for combustion turbines: Proceedings.** Knott, S. (ed.). (Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 70p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920317.

As part of its ongoing effort to help the utility industry improve power plant reliability, EPRI sponsored a one-day workshop on retrofit control systems for combustion turbines on April 10, 1986, in Houston, Texas. EPRI had five main objectives: (1) to promote exchange of ideas on the rationale and plans for control system replacements, (2) to share results and problems of replacing controls, (3) to determine utilities' future needs, (4) to explore the latest vendor offerings, and (5) to provide EPRI with information for possible research needs. In the morning session turbine users convened to hear utility and process industry representatives discuss their companies' experiences in retrofitting control systems. These individuals then formed a panel to answer questions from workshop attendees. In the afternoon session, five vendors, invited by EPRI to discuss their respective control systems, made up a second panel to answer previously prepared questions as well as questions from the floor. Combustion turbine users reconvened after the vendors panel to discuss utility problems, the control system market, and possible EPRI research in combustion turbine control systems.

24771 **(EPRI-CS—4781) Strategies for fossil plant life extension: Final report.** Reynolds, J.Z.; Coste, W.H.; Rochow, J.J.; Todoroff, J.N.; Vass, D.B.; Farber, M.A.; Sharpe-Hayes, M. (Consumers Power Co., Jackson, MI (USA); Temple, Barker and Sloane, Inc., Lexington, MA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 166p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920358.

Fossil plant life extension involves many strategic considerations that require analysis on a system-wide basis and include corporate level perspectives. This study of life extension strategies indicates there are substantial differences between utilities that will influence both the most desirable evaluation approach and life extension decisions. Historical and projected O & M practices can be expected to become a central issue in assessing the costs for maintaining unit availability and in determining justifiable levels of expenditures for extending life. The costs can be categorized to facilitate the evaluation process, as major modifications and component replacements have the highest potential for influencing decisions to extend plant life. Replacement capacity and energy values provide a reasonable basis for determining breakeven project values for priority ranking of units. Scenario analyses are suggested as an approach for assessing alternate strategies and evaluating risks and corporate impacts of life extension decisions. A case study of Consumers Power Company indicates that life extension is a desirable alternative for customers and investors, alike. Advantages and disadvantages, however, must be weighed in more detailed studies that would be necessary to recommend specific plant or unit modifications for life extension purposes. 29 figs., 41 tabs.

24772 **(EPRI-CS—4840) State-of-the-art maintenance and repair technology for fossil boilers and related auxiliaries: Final report.** Pack, R.W.; Resetar, P.J.; Nabow, S.E. (General Physics Corp., Columbia, MD (USA); Duke Power Co., Charlotte, NC (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 221p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920318.

This report is an assessment of the current state-of-the-art technology/techniques in the maintenance and repair of fossil-fired boilers and their related auxiliaries. It is based on a review of current practices of the US, Canadian, British, and German utility industries, as well as the pulp and petrochemical industries (US). Emphasized are major repair and preventive maintenance activities that contribute significantly to the cost of electrical generation in terms of lost megawatthours and/or material and labor resource requirements. Eighteen major activities associated with the maintenance and repair of boiler tubes, burners, hoppers, sootblowers, pulverizers, draft system expansion joints, and air heaters are evaluated, and current best technology/techniques are described for use by utility maintenance personnel. The preventive maintenance activities of boiler annual inspections and chemical cleaning of heat transfer surfaces are also addressed. In areas where cost-effective improvements in current techniques appear potentially justified, research and/or development needs are indicated. 22 refs., 82 figs.

24773 **(EPRI-CS—5104) A new emergency lubricating-oil system for steam turbine generators: Final report.** Kalan, G.L.; Oney, W.R.; Steenburgh, J.H.; Elwell, R.C. (General Electric Co., Schenectady, NY (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Apr 1987. 63p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920355.

A positive-displacement pump, powered by a turbine-shaft driven permanent magnet generator (PMG) can be used to provide lubricating oil over nearly the entire turbine generator speed range. The concept offers high reliability through its simplicity; switchgear, batteries and other auxiliaries are eliminated by hard-wiring the PMG to the pump induction drive motor. In this study, an existing PMG supplying power to the electrohydraulic control (EHC) system was evaluated as the power supply for an induction motor-driven screw pump running in a "wafting" mode as a backup to a conventional dc emergency oil system. The screw pump rotates all the time that the turbine shaft turns; check valves allow it to deliver oil instantly if the system pressure falls. It was found that the pump drive motor would start and run reliably with no adverse effects on the PMG or the electrohydraulic control (EHC) system. 6 refs., 23 figs., 11 tabs.

24774 **(ORNL/Sub—82-17473/1) Fault current limiter for generator bus protection (27 kV, 600 A, 330 kA).** Pflanz, H.M. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 88p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007830.

Purpose of this project was to develop a 27-kV fault current limiter to protect 600-A auxiliary transformers off a generator bus with prospective faults of 330 kA (rms sym). In this investigation, the current-limiting protector (CLP) principle was selected as the only feasible choice for a current limiter. Theoretical let-through currents of 60,000 A (peak), with energy values of 1.7 x 10^6 J and let-through i^2t values of 2.5 x 10^6 A^2s, were derived, for which double-barrel fuses are required. Various test techniques to overcome limitations of existing laboratory facilities were explored. The failure mode, effects, and criticality analysis (FMECA) showed that a uniformly highly reliable CLP system can be designed. Component tests of the CLP conductor of parallel fuses were performed. It was found that the conductor can withstand the high fuse-arc and recovery voltages of a 27-kV system. Separate fuse tests showed that the success of this project depends on the development of high-current fuses. The planned hybrid method (generator plus parallel capacitor discharge) will be capable of testing a CLP to the required ratings.

2002 Environmental Control Technology

REFER ALSO TO CITATION(S) 24397, 24458, 24462, 25779, 25829, 25844, 25962, 25963

24775 **(EPRI-CS—5055) Effects of cycling on environmental controls at fossil-fired power plants: Final report.** Blake, J.H. (Bechtel Group, Inc., San Francisco, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 168p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920319.

A scoping study has been carried out to define issues pertaining to environmental controls that result when power plant loads cycle. Environmental controls were considered to be the systems for gas handling downstream from the boiler, all the emission controls, the cooling systems, all aspects of water management, and solid waste handling and disposal. Cycling operations were defined as turndown and operation at low load, and startup and shutdown. Published literature, plant visits, utility personnel, vendors, and inhouse specialists provided information for the study. The principal issues that were defined include control of particulate emissions during startup; discharge of fly ash from electrostatic precipitators and fabric filters; pH control in wet scrubbers on increasing load; air heater plugging, corrosion, and temperature control; and excessive power usage when large fans and pumps do not modulate with load. Eleven research and development projects designed to alleviate these problems were recommended.

24776 **(PB—87-145348/XAB) Status of EPA's (Environmental Protection Agency's) LIMB (Limestone Injection Multistage Burner) demonstration program at Ohio Edison's Edgewater Unit 4. Report for September-December 1986.** Hendriks, R.V.; Nolan, P.S. (Babcock and Wilcox Co., Barberton, OH (USA)). Jan 1987. 20p. NTIS, PC A02/MF A01.

The paper describes and discusses the key design features of the retrofit of EPA's Limestone Injection Multistage Burner (LIMB) system to an operating, wall-fired utility boiler at Ohio Edison's Edgewater Station. It further describes results of the pertinent projects in EPA's LIMB program and shows how these results were used as the basis for the design of the system. The full-scale demonstration is expected to prove the effectiveness and cost of the LIMB concept for use on large-scale utility boilers. The equipment is now being installed at Edgewater, with system startup scheduled for May 1987.

24777 **(PB—87-145694/XAB) Cold weather plume study. Final report.** Vaughan, W.M. (Environmental Measurements, Inc., University City, MO (USA)). Dec 1986. 159p. NTIS, PC A08/MF A01.

While many studies of power-plant plume transport and transformation have been performed during the summer, few studies of these processes during the winter have been carried out. Accordingly, the U.S. Environmental Protection Agency and the Electric Power Research Institute jointly sponsored a field study in February 1981, the Cold Weather Plume study. It was based on St. Louis, Missouri, and focused on the plume from the Kincaid power plant located southeast of Springfield, Illinois. The objective was to characterize heterogeneous SOx and NOx chemistry in a power plant plume in cold weather. The report presents descriptive analyses of these measurememts. Cross-plume integrations of pollutant parameters are provided along with estimates of plume age. An integrated data base in consistent format was established to permit wider use of the measurements.

24778 **(PB—87-147187/XAB) Pilot-plant testing of electrostatic fabric filtration at Harrington Station.** Serrurier, R. (Southwestern Public Service Co., Amarillo, TX (USA)). Jan 1987. 34p. NTIS, PC A03/MF A01.

The paper gives results of pilot-plant tests of electrostatic fabric filtration (ESFF) at Harrington Station, near Amarillo, Texas. In early 1983, the pilot baghouse at Harrington Station was modified to conduct a testing program for ESFF. The tests conducted there successfully demonstrated the ESFF concept on a commercial scale and confirmed the favorable effect of reduced-filtration pressure drop previously observed in both laboratory and small scale tests. The unique woven-in electrode concept employed was successfully demonstrated from both bag construction and operational standpoints.

24779 **(TVA/ONRED/WRF—87/6) Paradise Steam Electric Plant, ashpond toxicity biomonitoring study, October 1986.** Moses, J.; Barr, W.C. (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). Jan 1987. 18p. NTIS, PC A02/MF A01. File Number DE87900619.

These studies will assess effects based on the general standard of "no toxic materials in toxic amounts," guided by procedures in the EPA Chronic Bioassay Manual (Horning and Weber 1985). TVA's testing procedures included one daphnid (7-day Ceriodaphnia sp. lifecycle test) and one fish (7-day fathead minnow, Pimephales promelas, growth test) assay selected from the approved group of chronic toxicity tests assay. This report presents results from the first of four quarterly chronic toxicity bioassays, initiated on October 14, 1986.

24780 **Technical status report development of lime based in-duct scrubbing - A cost effective SO/sub 2/ control technology.** Shilling, N.Z.; Samuel, E.A.; Pennline, H. (General Electric Environmental Services, Inc., Lebanon, PA). *Proceedings of the American Power Conference;* **48**: 365-372(Apr 1986). (CONF-860422—).

From American power conference; Chicago, IL, USA (14 Apr 1986).

Lime Based In-Duct Scrubbing (LIBIDS) was one of the candidate technologies receiving contract awards for pilot demonstration by the U.S. Department of Energy under the Acid Rain Precurser program. The concept as developed by General Electric utilizes rotary atomization of lime slurry directly within flue gas carrying ductwork to remove SO/sub 2/. This promises to be a very low capital cost method of SO/sub 2/ control with capital plus levelized operating cost estimated to be \$364/KW. Several significant technical milestones have been passed relative to proof of principle and ultimate commercialization. Based on positive results from a laboratory and supporting analytical work, a detailed engineering design has begun for a pilot plant.

2003 Power Transmission And Distribution

REFER ALSO TO CITATION(S) 24835

24781 **(CONF-870274—1) Automation of the Athens (Tennessee) electric power distribution system.** Gnadt, P.A. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007671.

From 1. international seminar on electric power distribution; Sao Paulo, Brazil (23 Feb 1987).

In an effort to provide electricity at a minimum cost, the electric utility industry continues to examine methods to operate generating plants, transmission lines, distribution equipment, and customer appliances more efficiently. The Athens Automation and Control Experiment (AACE) was conceived and implemented to address these needs. Located on the Athens Utilities Board system in Athens, Tennessee, the AACE is a highly instrumented system serving a closely surveyed group of 2000 consumers. AACE was designed as a test for distribution automation and control experiments. Observation of the results from the experiments will help to show which controls are worthwhile, what data and instrumentation are needed, and which monitoring and control functions for distribution systems are justified. Testing of the new automated system began in the fall of 1985, and the results may have a dramatic impact on the way electric power systems will be designed and operated in the future. Results from volt/var, system reconfiguration, and load control experiments are described.

24782 **(DOE/BP/17102—1) Transmission and distribution efficiency improvement R and D survey project: Final report.** Brooks, C.L.; Bonk, J.J.; Mauser, S.F.; Merrell, C.J.; Cordasen, R.A.; Smith, D.R. (Westinghouse Electric Corp., East Pittsburgh, PA (USA). Advanced Systems Technology Div.). Sep 1986. Contract AI79-84BP17102. 351p. NTIS, PC A16/MF A01; 1; GPO Dep. File Number DE87007783.

Purpose of this study was to identify and quantify those technologies for improving transmission and distribution (T & D) system efficiency that could provide the greatest benefits for utility customers in the Pacific Northwest. Improving the efficiency of transmission and distribution systems offers a potential source of conservation within the utility sector. An extensive review of this field resulted in a list of 49 state-of-the-art technologies and 39 future technologies. Of these, 15 from the former list and 7 from the latter were chosen as the most promising and then submitted to an evaluative test - a modeled sample system for Benton County PUD, a utility with characteristics typical of a BPA customer system. Reducing end-use voltage on secondary distribution systems to decrease the energy consumption of electrical users when possible, called "Conservation Voltage Reduction," was found to be the most cost effective state-of-the-art technology. Voltampere reactive (var) optimization is a similarly cost effective alternative. The most significant reduction in losses on the transmission and distribution system would be achieved through the replacement of standard transformers with high efficiency transformers, such as amorphous steel transformers. Of the future technologies assessed, the "Distribution Static VAR Generator" appears to have the greatest potential for technological breakthroughs and, therefore in time, commercialization. "Improved Dielectric Materials," with a relatively low cost and high potential for efficiency improvement, warrant R & D consideration. "Extruded Three-Conductor Cable" and "Six- and Twelve-Phase Transmission" programs provide only limited gains in efficiency and applicability and are therefore the least cost effective.

24783 **(DOE/CE/76237—T1) Hawaiian Deep Water Cable Program technical and management support services: Final report.** (VSE Corp., Alexandria, VA (USA)). Feb 1987. Contract AC01-83CE76237. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007942.

Purpose of the HDWC program is to determine the technical feasibility of establishing an electrical transmission system in water depths as great as 7000 feet and over a distance of 150 miles. This corresponds to the path from the NW shore of Hawaii to the SE shore of Oahu. This document reports on the technical and management support services for this program.

24784 **(DOE/RA/50150—23) Investigations on the impact of voltage and current harmonics on end-use devices and their protection: Summary report for period January 1, 1980-June 30, 1986.** Fuchs, E.F. (Colorado Univ., Boulder (USA)). Jan 1987. Contract AC02-80RA50150. 14p. NTIS, PC A02. File Number DE87008018.

After defining the relation between harmonic voltages and currents through harmonic impedances, the impact of harmonics on electromagnetic end-use devices such as transformers and machines is formulated based on analytical and experimental investigations. A harmonic factor representing the square of a weighted total harmonic distortion factor provides a mechanism for estimating the reduction of lifetime of electromagnetic end-use devices due to additional losses generated by sets of harmonics of frequencies below 2000 Hz. The forces and torques of saturable three-phase induction machines during starting and steady-state operation are computed from magnetic field solutions. Within the above frequency range the accuracy of induction watthour meters is reduced and the impact of harmonics or fractional harmonics (which exhibit a frequency other than those of harmonics and subharmonics) on distribution system relays can be severe. Also, the performance of television sets deteriorates for fractional harmonics below 2000Hz. The impact of harmonics on shunt capacitors limits the harmonic amplitudes with frequencies above 2000Hz. Depending upon the size of the system impedance either the harmonic voltages or the harmonic currents will be predominant. For small impedances the values of the harmonic currents will be limited by the permissible harmonic current loading of pole and substation transformers, whereas for large impedances the harmonic voltage amplitudes will be limited by the permissible additional losses in parallel connected electromagnetic end-use devices. The propagation of harmonics within a distribution feeder is such that for dispersed harmonic sources of the same kind no significant canceling of harmonic amplitudes occurs. Under certain circumstances the propagation of harmonics within a distribution feeder can cause resonances.

24785 **(ECRC/R—2112) Pole breaking proving tests of the PEST pole strength predictor.** Elcock, G. (Electricity Council Research Centre, Capenhurst (UK)). Nov 1986. 22p. Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK.

Up to thirty free standing wood poles were monitored for bending strength by two types of strength-prediction devices prior to ultimate bend tests to destruction. These two ECRC mechanical devices are compared for accuracy of failure prediction rates against the actual failure loads and the theoretical strengths as defined in BS 1990 Wood Poles for Overhead Lines. A mechanical device using a portion of pole subjected to a constant bending moment (the MKII PEST) most accurately interprets the elastic properties of the poles. A second mechanical device, more portable than the first, attempted with little success to interpret the elastic pole properties from a 3-point loading variable bending moment system.

24786 **(EPRI-EL—4935) Improved cellulosic insulation for distribution and power transformers: Final report.** Hettwer, P.F.; Vu, V.H. (McGraw-Edison Co., Franksville, WI (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 410p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920352.

Laboratory and paper mill studies investigated methods to improve the thermal stability, hygroscopicity, and mechanical and dielectric strength of cellulosic papers used for electrical insulation. This work, by identifying relationships between paper properties, provides a basis for further development of improved papers.

24787 **(EPRI-EL—5063-Vol.1) Nondestructive evaluation of wood utility poles: Volume 1, Current status: Interim report.** Bodig, J.; Anthony, R.W.; Goodman, J.R. (Colorado State Univ., Fort Collins (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 131p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920322.

Two methods show promise for nondestructive evaluation of both new and in-service utility poles. One method, using speed-of-sound measurements, predicts the strength of sets of poles. The other uses spectral analysis of sonic waves to assess the strength of individual poles.

24788 **(EPRI-EL—5090) Thermal stability of soils adjacent to underground transmission power cables: Phase 2: Final report.** Black, W.Z.; Hartley, J.G.; Bush, R.A.; Martin, M.A. Jr.; Griffin, J.D.A.; Bruce, J.D. (Georgia Inst. of Tech., Atlanta (USA). School of Mechanical Engineering; Georgia Power Co., Atlanta (USA); M and E Technology, Inc. (USA); Ontario Hydro, Toronto (Canada); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 87p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920339.

This report presents details of improved techniques for soil thermal property measurements. These measurements are an extension of soil thermal resistivity measurements and provide a means to measure soil thermal stability. Historically, soil thermal stability, sometimes called soil thermal runaway, has been linked to a maximum cable earth interface temperature. Results shown in this report indicate that heat flux or heat per unit length for a specific cable diameter controls soil thermal stability. A mathematical analysis was developed in Phase I of this work to provide a basis for measurement of soil thermal stability. This work was later extended to provide a correlation of soil thermal stability between single probe and multiple probe measurements. These stability measurements were made with a small thermal probe with heat inputs typical to that of buried cables. Additional tests were also performed with multiple probes which simulated multiple single conductor cable geometries. Test results were developed into an algorithm which was later incorporated into the thermal property analyzer developed earlier by Ontario Hydro. The completion of this project has yielded a realistic and reliable method to predict soil thermal stability.

24789 (EPRI-EM—5110) Structural composite cores for overhead power transmission conductors: Final report. Newaz, G.; Bigg, D.; Eiber, R. (Battelle Columbus Div., OH (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Apr 1987. 40p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920360.

This investigation was conducted as a feasibility study to identify potential composite systems capable of replacing the structural steel cable in power transmission conductors. The investigation was confined to a literature review of available published properties of composite materials. As a first step, the requirements for structural reinforcement in conductors were defined using the performance of ACSR conductors as a basis of reference. The mechanical properties of a number of unidirectionally oriented fibers were combined in this study. The unidirectionally oriented fibers appear to be the most feasible fiber orientation for a substitute structural core in the power transmission line. Four potential candidate composite materials were identified in the program. Several areas of future investigation are suggested to further evaluate the feasibility of using composite materials as the structural member in power transmission conductors.

24790 (ORNL—6204) Comparison of costs and benefits for dc and ac transmission. Stovall, J.P.; Bowles, J.P.; Diemond, C.C.; Eaton, R.A.; Gnadt, P.A.; Heyer, S.V.; Lasseter, R.H.; Lebow, M.A.; Long W.F.; McIver, J.C. (Oak Ridge National Lab., TN (USA)). Feb 1987. Contract AC05-84OR21400. 122p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007831.

The purpose of the study reported here was to examine generic cost differences between direct current (dc) and alternating current (ac) systems and to identify situations in which dc is clearly advantageous for long distance and bulk power transport. The study was also designed to determine the value of the dc technology when applied to transmission systems. This report presents cost comparisons between ac and dc substations and transmission lines as a function of capacity and voltage. It also presents a comparison of dc versus ac for increasing the capacity of existing corridors. Direct-current link operating stategies for enhancing the performance of the associated ac network are illustrated. Possible opportunities for simplification and cost reduction of dc converter stations are described. Both current and expected future enhancements for ac system operation are also identified to assist in making comparisons between equivalent systems. Information is presented to enable comparisons sufficiently detailed to determine "cost break-even distance," which is the transmission length at which the savings in dc line costs (compared to ac) equals the additional costs of the dc converter stations (compared to ac substations). However, it is emphasized that proper use of the concept requires the inclusion of all costs of implementation of those attributes available in the two technologies which are of sufficient value to the power system to be included in determining equivalent systems. The report attempts to bring together useful cost and performance information on ac and dc power transmission for the use of electric utility system in achieving economic and reliable power system designs when considering system additions, expansions, or modifications.

24791 (TVA/OP/OPS—87/2) Expanding the use of digital fault recorders for the small utility. Boyle, J.R. (Tennessee Valley Authority, Chattanooga (USA)). 18 Mar 1987. 17p. NTIS, PC A02/MF A01. File Number DE87900611.

This paper suggests two reasons why fault recorders have not been used by small utilities, namely, the inherent problems associated with photographic paper (heat) and mechanical limitations of oscillographs (running out of paper), and the ability to retain qualified engineering expertise to analyze oscillograms. With the advent of digital fault recorders, these problems are no longer valid. Digital fault recorders are capable of functioning properly in extreme ambient temperatures, and through the use of modems one engineer can analyze many oscillograms. A digital fault recorder does not run out of paper - it runs out of memory; but the uniqueness of a digital fault recorder is that sufficient memory can be added to satisfy most requirements and more importantly new data or the latest fault conditions are always added to the front end of the memory. Therefore, during a storm or serious interruption the less significant data is sloughed off and the more critical information retained at the front end of the memory for analysis. The ability to obtain the desired expertise to analyze oscillograms and make appropriate recommendations to correct deficiencies is more readily resolved with the installation of a digital fault recording device. Through the use of a modem one engineer could handle a large number of utilities that have digital fault recording devices.

21 NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 26361

24792 (NUREG/BR—0051-Vol.8-No.3) Power reactor events, May-June 1986. Massaro, S.A. (ed.). (Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data). Dec 1986. 42p. NTIS, PC A03/MF A01 - GPO. File Number TI87900419.

Power Reactor Events is a bi-monthly newsletter that compiles operating experience information about commercial nuclear power plants. This includes summaries of noteworthy events and listings and/or abstracts of USNRC and other documents that discuss safety-related or possible generic issues. It is intended to feed back some of the lessons learned from operational experience to the various plant personnel, i.e., managers, licensed reactor operators, training coordinators, and support personnel. Events at the following plants are reported: McGuire Unit 1; Susquehanna Units 1 and 2; Browns Ferry Units 1, 2, and 3; and River Bend Unit 1.

24793 Nuclear technologies in a sustainable energy system. Bauer, G.S.; Mc Donald, A. New York, NY; Springer-Verlag New York Inc. (1983). 331p. Springer-Verlag New York Inc., 175 Fifth Ave., New York, NY 10010.

This book presents papers on nuclear and thermonuclear reactors. Topics considered include energy strategies and nuclear power, self-sustaining systems of reactors, sustainable minireactors, small reactors, fast breeders and fusion-fission hybrids, the tokamak as a candidate for a D-T fusion reactor, the fusion breeder, hydrogen production through fusion, hydrogen production by means of electrolysis, the dense plasma focus, and radioactive waste management.

2101 Power Reactors, Non-breeding, Light-water Moderated, Boiling Water Cooled

REFER ALSO TO CITATION(S) 24814, 24825, 24826, 24836, 24838, 24843, 24846, 24854, 24855, 24856, 24861

24794 (EPRI-NP—4970) Utility guidelines for reactor noise analysis: Final report. Sweeney, F.J. (Oak Ridge National Lab., TN (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. Contract AC05-84OR21400. 85p. NTIS, PC A05/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1; GPO Dep. File Number DE87006955.

Noise analysis techniques have been extensively utilized to monitor the health and performance of nuclear power plant systems. However, few utilities have adequate programs to effectively utilize these techniques. These programs usually provide low-quality data, which can lead to misinterpretation and false alarms. The objective of this work is to provide utilities and noise analysts with guidelines for data acquisition, data analysis, and interpretation of noise analysis results for surveillance and diagnosis of reactor systems.

24795 (EPRI-NP—5064-M) Corrosion-assisted cracking of stainless and low-alloy steels in LWR [light water reactor] environments: Final report. Ford, F.P.; Taylor, D.F.; Andresen, P.L.; Ballinger, R.G. (General Electric Co., Schenectady, NY (USA). Materials Lab.). Feb 1987. 118p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920308.

The primary objective of this investigation was to develop a quantitative model which could correctly predict the effects of material, environment, and stress-related parameters on the stress-corrosion and the corrosion fatigue behavior of stainless and low-alloy steels in high-temperature water. The approach used was, first, to hypothesize that the film-rupture mechanism of environmentally controlled crack propagation was appropriate for these ductile alloy/aqueous environment systems; second, to quantify the parameters of importance in this mechanism, i.e., the crack-tip environment and the electrode reaction rates in such an environment; and, finally, to evolve theoretical predictions of crack propagation rates for variations in material, environment, and stress parameters, and to examine the validity of the original hypothesis by comparing these predictions with observation. It was concluded that the film-rupture model of environmentally enhanced cracking was statistically valid for the stainless steel and low-alloy steel/high-temperature water systems - at least for the metallurgical and environmental conditions peculiar to those in piping and pressure vessels of light water reactors.

24796 (NUREG/CR—4813) Assessment of leak detection systems for LWRs. Kupperman, D.S. (Argonne National Lab., IL (USA); Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Jan 1987. Contract W-31109-ENG-38. 47p. (ANL—86-52). NTIS, PC A03/MF A01 - GPO. File Number TI87005739.

This topical report summarizes work performed by the Argonne National Laboratory as subcontractor on on-line leak monitoring of LWRs during the 12 months from October 1985 to September 1986. The use of at least three different methods is recommended for leakage detection in reactors. Monitoring of sump-flow and airborne particulate radioactivity are suggested. A third method could involve monitoring condensate flow rate from air coolers or monitoring of airborne gaseous radioactivity.

24797 Design of a round robin UT program for piping. Doctor, S.R.; Selby, G.P.; Heasler, P.G. (Battelle Pacific Northwest Lab., Richland, WA). pp 69-70 of NDE reliability through round robin testing. Vol. 1. Fong, J.T.; Mordfin, L.; Hedden, O.F.; Bush, S.H. New York, NY; American Society of Mechanical Engineers (1986). (CONF-860722—). Contract AC06-76RL01830.

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

A multi-year program in progress at Battelle under sponsorship of the U.S. Nuclear Regulatory Commission has as one of its primary objectives measuring the effectiveness of inservice inspection (ISI) performed on all required nuclear components in U.S. light water reactors. This program has been split into two tasks. The first task addresses ISI for the primary piping system. The second task addresses the effectiveness of ISI for the pressure vessel. The initial years of the program have focused on the first task pertaining to the primary piping. Although engineers and technicians performed many laboratory measurements, it was decided that the only way to establish the performance of ISI teams was through the utilization of a round robin test program. It was impractical to try to include all inspection conditions in the round robin, so a subset of the most important conditions were selected for intensive measurement. Furthermore, the round robin design allows several standard statistical models to be fit to the inspection data. These models will be used to extend the results to pipe diameters, wall thickness, and defect types that were not included in the round robin.

24798 Probabilistic analysis of initiation and early growth of stress corrosion cracks in BWR piping. Harris, D.O.; Dedhia, D.D.; Eason, E.D. New York, NY; American Society of Mechanical Engineers (1986). 7p. (CONF-860722—). American Society of Mechanical Engineers, 345 East 47 St., New York, NY 10017.

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

The purpose of this paper is to describe a probabilistic model of the initiation and early growth of stress corrosion cracks in sensitized 304 stainless steel weldments in boiling water reactor (BWR) piping. This treatment of crack initiation provides an extension of earlier models of reactor piping reliability which considered only the influence of pre-existing cracks. The inclusion of crack initiation is needed to provide agreement with field observations of cracking in BWR piping. A probabilistic treatment of this phenomenon is appropriate because of both the apparent randomness of observed field failures and the large scatter observed in related laboratory tests. The model is based on quantification of the scatter in laboratory observations once the influence of the major independent variables has been accounted for (stress level or strain rate, coolant oxygen level, temperature, and degree of sensitivity).

24799 Subchannel analysis applied to neutron noise investigation in a boiling water reactor. Khan, H.J. Seattle, WA; Univ. of Washington (1986). 298p. University Microfilms Order No. 86-26,662.

Thesis (Ph. D.).

Drift flux parameters were developed for subchannel configuration of BWR rod bundle geometry in order to calculate the void fraction and void propagation velocities inside the individual subchannels. Void fraction calculations were performed using subchannel drift flux code CANAL. Using void and flow distributions, values of the distribution parameters were estimated for bundle averaged void fraction calculation. The simple geometries taken into consideration are circular tubes, rectangular channels, and parallel plates. A C_0 model was also developed for parallel subchannel configuration. Successful prediction of average void fraction is observed for the annular rod bundle geometry of the FRIGG experiment. A C_0 model developed for one-dimensional subchannel geometry was applied to annular subchannels using Zuber-Findlay's void quality model. This is the first time subchannel void fraction is predicted by subchannel drift flux parameters. It appears that the magnitude of C_0 varies between subchannels but remains almost constant within each subchannel. A two-dimensional derivation of C_0 for the three types of subchannel (corner, side, and center) of BWR rod-bundle geometry was developed.

2102 Power Reactors, Non-breeding, Light-water Moderated, Non-boiling Water Cooled

REFER ALSO TO CITATION(S) 24794, 24796, 24797, 24814, 24826, 24831, 24834, 24837, 24838, 24841, 24842, 24844, 24845, 24846, 24850, 24851, 24852, 24853, 24856, 24857, 24859, 24861, 24863, 25233

24800 (DOE/BP—747) Draft WNP-1 [Washington Nuclear Plant] and -3 study: 1987 resource strategy. (USDOE Bonneville Power Administration, Portland, OR). 11 Dec 1986. 119p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006832.

With this study Bonneville seeks to conclude whether WNP-1 and -3 should be preserved, terminated, or completed on a fixed construction schedule. Bonneville has completed an intensive review and analysis of issues related to this question. Bonneville's draft study conclusion is that preserving both WNP-1 and -3 is the most prudent course of action in the short run, pending the resolution of several critical factors. This conclusion is based on the following key study findings. Bonneville found that, economically, continued preservation is the lower-risk alternative. Termination creates the risk that the region would have to eventually build new coal plants, costing over $2 billion more in present value than completing WNP-1 and -3. Alternatively, preservation creates the smaller risk that preservation costs, amounting to $150 million in present value, will be spent over the next 14 years on projects that turn out not to be needed.

24801 Application of noise analysis technique for monitoring the moderator temperature coefficient of reactivity in pressurized water reactors. Shieh, D.J.; Upadhyaya, B.R.; Sweeney, F.J. (Institute of Nuclear Energy Research). *Nuclear Science and Engineering;* **95**: No. 1, 14-21(Jan 1987).

A new technique, based on the noise analysis of neutron detector and core-exit coolant temperature signals, is developed for monitoring the moderator temperature coefficient of reactivity in pressurized water reactors (PWRs). A detailed multinodal model is developed and evaluated for the reactor core subsystem of the loss-of-fluid test (LOFT) reactor. This model is used to study the effect of changing the sign of the moderator temperature coefficient of reactivity on the low-frequency phase angle relationship between the neutron detector and the core-exit temperature noise signals. Results show that the phase angle near zero frequency approaches -180 deg for negative coefficients and 0 deg for positive coefficients when the perturbation source for the noise signals is core coolant flow, inlet coolant temperature, or random heat transfer.

24802 **Vibrational measurements of line-mounted equipment on the LOFT feedwater system.** Ware, A.G.; Nitzel, M.E. (Idaho National Engineering Lab., Idaho Falls, ID). pp 85-90 of Seismic engineering for piping systems, tanks and power plant equipment. Vol. 108. Liu, T.H.; Chen, P.Y.; Patel, Y.A.; Ma, D.C. New York, NY; American Society of Mechanical Engineers (1986). (CONF-860722—).

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

As part of the NRC/EG & G Equipment Qualification Program, the vibration response of the Loss of Fluid Test (LOFT) feedwater system was monitored to determine spectral acceleration levels typical for line mounted equipment. Accelerometers were placed on the main feedwater pump, three valves, and one piping support. The response of the system was monitored using a two channel analyzer. Measurements were recorded at four power levels as reactor power was increased from the source range to 64% of full power. The resulting spectra show responses up to 3000 Hz. Observations concerning the data were made by computing and evaluating the Fourier transforms for the test. Maximum spectral amplitudes of 0.05 to 0.4 gs rms were recorded. No correlation of response level vs. feedwater flowrate was detected. Examples of Fourier spectra of the feedwater system components are included in the paper. These are considered typical of those which would be expected in a nuclear plant auxiliary feedwater system.

24803 **Analytical and experimental investigation of natural circulation transients in a model pressurized water reactor.** Massoud, M. College Park, MD; Univ. of Maryland (1986). 272p. University Microfilms Order No. 86-28,996.

Thesis (Ph. D.).

Natural circulation phenomena in a simulated PWR was investigated experimentally and analytically. The experimental investigation included determination of system characteristics as well as system response to the imposed transient under symmetric and asymmetric operations. System characteristics were used to obtain correlation for heat transfer coefficients in heat exchangers, system flow resistance, and system buoyancy head. Asymmetric transients were imposed to study flow oscillation and possible instability. The analytical investigation encompassed development of mathematical model for single-phase, steady state and transient natural circulation as well as modification of existing model for two phase flow analysis of phenomena such as small break LOCA, high pressure coolant injection, and pump coast down. The developed mathematical model for single-phase analysis was computer coded to simulate the imposed transients. The computer program, entitled Symmetric and Asymmetric Analysis of Single-Phase Flow (SAS), were employed to simulate the imposed transients. It closely emulated the system behavior throughout the transient and subsequent steady state. Modifications for two-phase flow analysis included addition of models for once through steam generator and electric heater rods. Both programs are faster than real time.

24804 **Simulation of thermohydraulic phenomena in a pressurized water reactor primary loop.** Popp, M. College Park, MD; Univ. of Maryland (1986). 283p. University Microfilms Order No. 86-25,716.

Thesis (Ph. D.).

Several important fluid flow and heat transfer phenomena essential to nuclear power reactor safety were investigated. Scaling and modeling laws for pressurized water reactors are reviewed and a new scaling approach focusing on the overall loop behavior is presented. Scaling criteria for one-and two-phase natural circulation are developed, as well as a simplified model describing the first phase of a small break loss of coolant accident. Reactor vessel vent value effects are included in the analysis of steady one-phase natural circulation flow. Two new dimensionless numbers, which uniquely describe one-phase flow in natural circulation loops, were deduced and are discussed. A scaled model of the primary loop of a typical; Babcock and Wilcox reactor was designed, built, and tested. The particular prototype modeled was the TMI unit 2 reactor. The electrically heated, stainless steel model operates at a maximum pressure of 300 psig and has a maximum heat input of 188 kW. The model is about 4 times smaller in height than the prototype reactor, with a nominal volume scale of 1:500. Experiments were conducted establishing subcooled natural circulation in the model loop. Both steady flow and power transients were investigated. Measurements included primary side temperatures, hot leg velocities, and other primary and secondary loop performance data.

24805 **Optimization of core reload design for low leakage fuel management in pressurized water reactors.** Kim, Y.J. Lafayette, IN; Purdue Univ. (1986). 238p. University Microfilms Order No. 87-00,913.

Thesis (Ph. D.).

A new method was developed to optimize pressurized water reactor core reload design for low leakage fuel management, a strategy recently adopted by most utilities to extend cycle length and mitigate pressurized thermal shock concerns. The method consists of a two-stage optimization process which provides the maximum cycle length for a given fresh fuel loading subject to power peaking constraints. In the first stage, a best fuel arrangement is determined at the end of cycle in the absence of burnable poisons. A direct search method is employed in conjunction with a constant power, Haling depletion. In the second stage, the core control poison requirements are determined using a linear programming technique. The solution provides the fresh fuel burnable poison loading required to meet core power peaking constraints. An accurate method of explicitly modeling burnable absorbers was developed for this purpose. The design method developed here was implemented in a currently recognized fuel licensing code, SIMULATE, that was adapted to the CYBER-205 computer. This methodology was applied to core reload design of cycles 9 and 10 for the Commonwealth Edison Zion, Unit-1 Reactor. The results showed that the optimum loading pattern for cycle 9 yielded almost a 9% increase in the cycle length while reducing core vessel fluence by 30% compared with the reference design used by Commonwealth Edison.

2103 Power Reactors, Non-breeding, Graphite Moderated

REFER ALSO TO CITATION(S) 24814, 24827, 24833, 24839, 24863, 25833

24806 **(ESC-WR—86-23) Aftermath of Chernobyl. Effects of the Chernobyl-accident on public opinion about nuclear power.** Midden, C.J.; Verplanken, B. (Stichting Energieonderzoek Centrum Nederland, Petten. Energie Studie Centrum). Nov 1986. 34p. (In Dutch). Energie Studie Centrum ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

A number of effects of the Chernobyl-accident on public opinion about nuclear power is discussed. The analysis is based on a comparison of a survey conducted shortly after Chernobyl and a number of measurements in The Netherlands between 1982 and 1986. The conclusions can be summarized as follows: attitudes towards nuclear power and especially towards building new power stations have become much more negative after the disaster in Chernobyl; although a majority of the population now wants to close existing nuclear power stations, there appears strong support for continuation of nuclear research. The structure of the nuclear debate has not changed fundamentally. Supporters and opponents have kept the same demographic characteristics. The arguments which distinguish them have not changed, except that the expectation of a serious accident has an increased impact on attitudes. A majority of the population felt the information after the accident not sufficient. Since 1982 attitudes towards coal also have become more negative, mainly as a consequence of the higher visibility of effects of acid rain. 11 figs., 10 tabs.

2104 Power Reactors, Non-breeding, Otherwise Moderated Or Unmoderated

REFER ALSO TO CITATION(S) 24814

2105 Power Reactors, Breeding

REFER ALSO TO CITATION(S) 24849, 24858

24807 **The Integral Fast Reactor concept.** Till, C.E.; Chang, Y.I. (Argonne National Lab., Argonne, IL). *Proceedings of the American Power Conference;* **48**: 688-693(Apr 1986). (CONF-860422—).

From American power conference; Chicago, IL, USA (14 Apr 1986).

The Integral Fast Reactor (IFR) is an innovative LMR concept, being developed at Argonne National Laboratory, that exploits the inherent properties of liquid metal cooling and metallic fuel to achieve breakthroughs in economics and inherent safety. This paper describes the key features and potential advantages of the IFR concept, its technology development status, fuel cycle economics potential, and its future development path.

24808 **Design rule for fatigue of welded joints in elevated-temperature nuclear components.** O'Connor, D.G.; Corum, J.M. (Oak Ridge National Lab., Oak Ridge, TN). pp 69-76 of Symposium on ASME codes and recent advances in PVP and valve technology including a survey of operations research methods in engineering. Vol. 109. Fong, J.T.; Hollinger, G.L.; Gowda, B.; Ezekoye, L.I.; Levary, R.R. New York, NY; American Society of Mechanical Engineers (1986). (CONF-860722—). Contract AC05-84OR21400.

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

Elevated-temperature weldment fatigue failures have occurred in several operating liquid-metal reactor plants. Yet, ASME Code Case N-47, which governs the design of such plants in the United States, does not currently address the reduced fatigue strength of weldments. To rectify this shortcoming the Code Subgroup on Elevated Temperature Design recently proposed a fatigue strength reduction factor for austenitic and ferritic steel weldments. The factor is based on a variety of weld metal and weldment fatigue data generated in the United States, Europe, and Japan. This paper describes the factor and its bases, and it presents the results of confirmatory fatigue tests conducted at Oak Ridge National Laboratory on 316 stainless steel tubes with axial and circumferential welds of 16-8-2 filler metal. These test results confirm the suitability of the design factor, and they support the premise that the metallurgical notch effect produced by yield strength variations across a weldment is largely responsible for the observed elevated-temperature fatigue strength reduction.

24809 **On the role and technological readiness of fast breeders and fusion-fission hybrids in the world nuclear future.** Abdel-Khalik, S.I.; Kulcinski, G.L.; Kessler, G. (Nuclear Engineering Dept., Univ. of Wisconsin, Madison, WI). pp 87-106 of Nuclear technologies in a sustainable energy system. Bauer, G.S.; Mc Donald, A. New York, NY; Springer-Verlag New York Inc. (1983).

This study focuses on the future role of hybrids and fast breeders and the possible time windows for their introduction. The technological readiness of both reactors and associated fuel-cycle facilities during these time windows is examined. Four possible options allowing world nuclear demand to be met within the known uranium resource base are identified: breeders alone rapidly introduced in the year 2000; hybrids alone rapidly introduced in 2000; hybrids and breeders simultaneously introduced in 2000 following traditional market-penetration rates; and hybrids and breeders rapidly introduced simultaneously in 2020.

24810 **Small reactors in a neutron-abundant world.** Hilborn, J.W. (Reactor Physics Branch, Atomic Energy of Canada Ltd., Chalk River, Ontario K0J 1J0). pp 75-86 of Nuclear technologies in a sustainable energy system. Bauer, G.S.; McDonald, A. New York, NY; Springer-Verlag New York Inc. (1983).

In a future world of neutron abundance, fissile fuel for small reactors could be produced from uranium and thorium using breeder reactors, fusion reactors, and spallation accelerators. Although the most successful application of small reactors to date has been in nuclear submarines, there appears to be a growing need for small (< 250 MWe) nuclear energy sources in developing countries and remote locations. However, in recent years only the Soviet Union and India have actually built multiple commercial units. Several dual-purpose reactors and heat-only reactors have been proposed, but future commitments are uncertain. Assuming the long-term availability of fissile fuels at a present-day cost of $200/g in a fabricated core, low-temperature heat from small reactors could probably compete with oil heat, if the price of oil were to double.

2106 Power Reactors, Auxiliary, Mobile, Package, And Transportable

REFER ALSO TO CITATION(S) 24810

2107 Regulation And Licensing

REFER ALSO TO CITATION(S) 24837, 24894

24811 **(NUREG—0540-Vol.9-No.1) Title list of documents made publicly available, January 1-31, 1987.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Administration). Mar 1987. 339p. NTIS, PC A15/MF A01 - GPO. File Number TI87900572.

This document is a monthly publication containing descriptions of information received and generated by the US NRC. This information includes (1) docketed material associated with civilian nuclear power plants and other uses of radioactive materials, and (2) nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. The following indexes are included: Personal Author Index, Corporate Author Index, Report Number Index, and Cross Reference to Principal Documents Index.

24812 **(NUREG—1224) Safety evaluation report related to the renewal of the operating license for the University of New Mexico Research Reactor (Docket No. 50-252).** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Mar 1987. 49p. NTIS, PC A03/MF A01 - GPO. File Number TI87900595.

This Safety Evaluation Report for the application filed by the University of New Mexico (UNM) for renewal of Operating License No. R-102 to continue to operate its research reactor has been prepared by the Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission. The facility is located on the campus of the University of New Mexico in Albuquerque, New Mexico. The staff concludes that the reactor can continue to be operated by the University of New Mexico without endangering the health and safety of the public. 7 refs., 7 figs., 2 tabs.

24813 **(NUREG—1258) Evaluation procedure for simulation facilities certified under 10 CFR 55: Draft report.** Laughery, K.R.; Plott, C.; Wachtel, J. (Nuclear Regulatory Commission, Washington, DC (USA). Div. of Human Factors Technology). Mar 1987. 136p. NTIS, PC A07/MF A01 - GPO. File Number TI87900592.

This document describes the process to be followed by the NRC for the inspection of simulation facilities certified by facility licensees in accordance with 10CFR55. Such inspections are divided into four major technical areas: performance testing; physical fidelity/human factors; control capabilities; and design, updating, modification and testing. Inspections will be performed by NRC staff with interdisciplinary skills including license examiner, operations specialist and human factors expert. Inspections may consist of off-site and/or on-site phases. The off-site phase consists of an examination of simulation facility documentation, and the identification of those operations that may be considered for use in on-site performance testing. In the on-site phase, the staff will work with the facility licensee to conduct a review of the four technical areas, and to evaluate the results of tests that are conducted. Findings will be based upon the staff's judgment of the degree of compliance of the simulation facility with 10CFR55 in terms of its suitability for the conduct of operating examinations.

24814 **(SAND—86-2106) Risk-based Regulatory Evaluation Program methodology.** DuCharme, A.R.; Sanders, G.A.; Carlson, D.D.; Asselin, S.V. (Sandia National Labs., Albuquerque, NM (USA); Energy, Inc., Idaho Falls, ID (USA)). Jan 1987. Contract AC04-76DP00789. 53p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87004778.

The objectives of this DOE-supported Regulatory Evaluation Progrwam are to analyze and evaluate the safety importance and economic significance of existing regulatory guidance in order to assist in the improvement of the regulatory process for current generation and future design reactors. A risk-based cost-benefit methodology was developed to evaluate the safety benefit and cost of specific regulations or Standard Review Plan sections. Risk-based methods can be used in lieu of or in combination with deterministic methods in developing regulatory requirements and reaching regulatory decisions.

24815 **A preliminary evaluation of the U.S. Nuclear Regulatory Commission's Standard Review Plan with regard to relicensing.** Jacobs, P.T. (Idaho National Engineering Lab., EG and G Idaho, Inc., P.O. Box 1625, Idaho Falls, ID 83415). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 580-582(Feb 1987). (CONF-861007—). Contract AC07-76ID01570.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

A preliminary evaluation of the U.S. Nuclear Regulatory Commission's (NRC's) Standard Review Plan (SRP) was conducted with the goal of identifying areas that might need revision if the SRP is used for relicensing/license renewal. The SRP is presently used to guide NRC staff reviewers in assessing safety analysis reports submitted by applicants for construction permits and operating licenses for nuclear power plants. The paper summarizes the findings and recommendations based on the evaluation.

2108 Economics

REFER ALSO TO CITATION(S) 24800, 24809, 24832

22 NUCLEAR REACTOR TECHNOLOGY

REFER ALSO TO CITATION(S) 26378

2201 Theory And Calculation

REFER ALSO TO CITATION(S) 24799, 24848, 24858

24816 **Subcriticality measurements for coupled uranium metal cylinders using the /sup 252/Cf-source-driven neutron noise analysis method.** Mihalezo, J.T.; King, W.T.; Blakeman, E.D. (Oak Ridge National Lab., Instrumentation and Controls Div., Oak Ridge, TN 37831). *Nuclear Science and Engineering;* **95**: No. 1, 1-13(Jan 1987). Contract AC05-84OR21400.

Experiments performed with two coupled uranium metal cylinders are the first application to coupled systems of the /sup 252/Cf-source-driven neutron noise analysis method for obtaining the subcritical neutron multiplication factor. These coaxial cylinders were separated axially by various thicknesses of either air or borated plaster between the flat surfaces. In all measurements, the /sup 252/Cf neutron source was located at the center of the outer flat surface of one cylinder, and the two detectors were located in three configurations. By comparing the subcriticality from the measurements performed with borated plaster separating the uranium cylinders to those separated by air, it was found that the neutron multiplication factor was always increased by the insertion of borated plaster between the cylinders, regardless of their separation.

2202 Components And Accessories

REFER ALSO TO CITATION(S) 24804, 24847, 25233

24817 **(EPRI-NP—5057) Analysis of cracked pipe weldments: Final report.** Ganta, B.R.; Ayres, D.J. (Combustion Engineering, Inc., Windsor, CT (USA). Power Systems Div.; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 99p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920307.

This report presents elastic-plastic fracture mechanics finite element calculations of a pipe weldment with a through-wall circumferential crack. The analysis compares a solution for a bimetallic pipe weldment with those for homogeneous all-base and all-weld material pipe models. Austenitic stainless steel pipe is modeled with appropriate differences for the stronger, but less tough, weld metal surrounding the crack. The elastic-plastic analyses show that the bimetallic weldment model pipes having typical weld widths, equal to the pipe wall thickness, behave similar in applied crack driving force curves to those of the all-base metal pipes rather than the all-weld metal pipes. The use of all-weld pipe model for the bimetallic case would over predict the crack initiation and instability loads. The detailed finite element solutions for prediction of crack initiation and instability loads are also compared with estimation formulas. The finite element analyses indicate that good and reasonably conservative estimations can be obtained from an estimation scheme for the homogenous all-base or all-weld material pipes if the material stress-strain properties were properly modelled with the Ramberg-Osgood law in the low strain region of the curve. The analyses performed indicate that a bounding method which uses the base material stress-strain properties and the weldment fracture toughness properties in the estimation scheme gives solutions which are in better agreement with the detailed finite element calculations for the weldment pipe than the homogeneous all-weld pipe model. A correction factor is suggested to obtain the crack initiation and instability loads of the weldment pipe from those predicted by the bounding method.

24818 **Heat dissipating nuclear reactor with metal liner.** Gluekler, E.L.; Hunsbedt, A.; Lazarus, J.D. (to Dept. of Energy, Washington, DC). US Patent 4,650,642. 17 Mar 1987. Filed date 21 Nov 1985. vp.

A nuclear reactor containment is described comprising: reactor vessel means disposed in a metal cavity located partially or completely below the surface of the earth in a cavity, a cast steel containment member partially surrounding the reactor vessel means and having an inner surface conforming in shape to an exterior surface of the reactor vessel means. The cast steel member has a solid thick base plate which extends at least across a bottom area of the reactor vessel means, means located below the base plate but adjacent to it for feeding water to a porous media disposed in the hot zone immediately underneath the base plate. The water is converted to steam when the temperature of the hot zone exceeds the boiling point of water, means of venting the steam so formed to the atmosphere, and means in contact with the base plate for supporting at least the base plate and for conducting heat away from the base plate.

24819 **An evaluation of information sources and requirements for nuclear plant-aging research with life-extension implications.** Jacobs, P.T. (Idaho National Engineering Lab., EG and G Idaho Inc., P.O. Box 1625, Idaho Falls, ID 83415). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 571-575(Feb 1987). (CONF-861007—). Contract AC07-76ID01570.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Information requirements for plant-aging and life-extension research are discussed. Various information sources that have been used in plant-aging studies and reliability assessments are described. Data-base searches and analyses were performed for a specific system using several data bases and plant sources. Comments are provided on the results using the various information sources.

24820 **Variation of structural damping with response amplitude in piping systems.** Ware, A.G. (EG and G Idaho, Inc., Idaho National Engineering Lab., Idaho Falls, ID). pp 13-18 of Seismic engineering for piping systems, tanks and power plant equipment. PVP-Vol. 108. Liu, T.H.; Chen, P.Y.; Patel, Y.A.; Ma, D.C. New York, NY; American Society of Mechanical Engineers (1986). (CONF-860722—).

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

From tests conducted over the last several years, it has become apparent that structural damping is not a single number applicable to all piping systems, but is highly dependent on piping system parameters such as supports, response amplitude, and insulation. As a result, there is considerable scatter in the available data. Furthermore, the relationships between the parameters and damping are often highly complex, interrelated, and difficult to predict. From tests of piping supported by various typical methods, two basic types of energy dissipation in the supports can be observed. The first is friction such as between spring hangers and their housings or in the internal mechanisms of constant force hangers. The second is impacting such as occurs in snubbers, rigid struts, and rod hangers. Overall, these effects lead to a wide variety of possibilities that can occur at low vibration levels and can change with only a slight perturbation of vibration amplitude.

24821 **PISC-II data studies.** Heasler, P.G.; Littlefield, J.S. (Battelle Pacific Northwest Labs., Richland, WA). pp 155-156 of NDE reliability through Round Robin testing. Vol. 1. Fong, J.T.; Mordfin, L.; Hedden, O.F.; Bush, S.H. New York, NY; American Society of Mechanical Engineers (1986). (CONF-860722—). Contract AC06-76RL01830.

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

Pacific Northwest Laboratory (PNL) has been collecting Round Robin Pressure Vessel data for analysis in connection with a Nondestructive Evaluation/Fracture Mechanics program sponsored by the NRC. One important source of such data has been the PSIG studies. The Joint Research Centre at Ispra has been kind enough to provide PNL with the PISC-I inspection and destructive analysis data. This paper discusses the data-reporting format used during the PISC-II inspections performed at the EPRI NDE Center and presents an inventory of the raw data collected. The authors also discuss some general problems that surfaced during the review of the data. Because the PISC-II inspections are still in progress, no specific inspection results are presented in this paper.

24822 **New techniques for modeling the reliability of reactor pressure vessels.** Johnson, K.I.; Simonen, F.A.; Liebetrau, A.M.; Simonen, E.P. New York, NY; American Society of Mechanical Engineers (1986). 9p. (CONF-860722—). American Society of Mechanical Engineers, 345 East 47 St., New York, NY 10017.

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

In recent years several probabilistic fracture mechanics codes, including the VISA code, have been developed to predict the reliability of reactor pressure vessels. This paper describes several new modeling techniques used in a second generation of the VISA code entitled VISA-II. Results are presented that show the sensitivity of vessel reliability predictions to such factors as inservice inspection to detect flaws, random positioning of flaws within the vessel wall thickness, and fluence distributions that vary throughout the vessel. The algorithms used to implement these modeling techniques are also described. Other new options in VISA-II are also described in this paper. The effect of vessel cladding has been included in the heat transfer, stress, and fracture mechanics solutions in VISA-II. The algorithms for simulating flaws has been changed to consider an entire vessel rather than a single flaw in a single weld. The flaw distribution was changed to include the distribution of both flaw depth and length. A menu of several alternate equations has been included to predict the shift in RT/sub NDT/. For flaws that arrest and later re-initiate, an option was also included to allow correlating the current arrest toughness with subsequent initiation toughnesses.

2203 Fuel Elements

24823 **Fuel handling apparatus for a nuclear reactor.** Hawke, B.C. (to Dept. of Energy, Washington, DC). US Patent 4,647,423. 3 Mar 1987. Filed date 26 Aug 1983. vp.

This patent describes a fuel handling apparatus for operation through an opening in the side of a reactor vessel having a plurality of fuel elements disposed in an array within the vessel, the apparatus comprising: a support housing for affixation to an exterior portion of the vessel, the housing enclosing an interior space having a generally horizontal longitudinal axis; a support member mounted for motion longitudinally of the housing within the housing; a first arm supported by the support member and pivotal about a vertical axis through the support member; a second arm supported by the first arm and pivotal about a horizontal axis through the first arm; means for pivoting the first and second arms about their respective axes; reversible extendable lifting means fixedly supported by the second arm for positively moving the fuel elements upward and downward. The lifting means includes a storable tubular extendable member comprising at least one ribbon which may be compactly stored on a reel and which may be extended into an elongated, relatively rigid configuration; grapple means supported by the lifting means for releasably connected the lifting means to the fuel elements; and lateral transport means for moving the support member longitudinally of the housing.

24824 **Nuclear fuel pin scanner.** Bramblett, R.L.; Preskitt, C.A. (to Dept. of Energy, Washington, DC). US Patent 4,647,420. 3 Mar 1987. Filed date 18 Mar 1985. vp.

A nuclear fuel pin scanner system is described for inspecting nuclear fuel pins at a throughput rate to determine the uniformity and amount of fissile material contained in the fuel pin, comprising: a rotary irradiator having a source of activating radiation located centrally thereof, the irradiator having a plurality of circumferentially spaced positions thereabout for supporting fuel pins in radially spaced relation to the source of activating radiation; means for feeding and discharging the fuel pins singly into and from the irradiator at the throughput rate; means for rotating the irradiator and fuel pins contained therein about the source of activating radiation whereby each fuel pin is irradiated for an extended period of time relative to the throughput rate; and detector means downstream of the irradiator comprising an array of axially spaced radiation detectors for detecting radiation from segments, respectively, of each fuel pin during oscillatory movement of the fuel pin relative to the detector means to achieve an effective total scanning time for the pin equal to a detection period times the number of segments.

2204 Control Systems

24825 **(EPRI-NP—5081) An evaluation of the use of signal validation techniques as a defense against common-cause failures: Final report.** Kujawski, E.; Jacobs, I.M.; Smith, A.M. (Los Alamos Technical Associates, Inc., NM (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 88p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920311.

The major objective of this project is to assess on-line signal validation techniques as a defense against common cause failures in instrumentation and control systems. The present study specifically addressed the BWR vessel level instrumentation, which has been a long-standing safety concern. The results of this study consist of (1) an assessment of current fault detection and isolation capabilities, (2) development of a generalized decision estimator for detection and isolation of common cause failures, and (3) quantification of safety impact of various signal validation design options. The major output of this study was the development of a generalized decision estimator with the ability to synthesize diverse information, identify plausible alternatives, and draw inferences from the available information or evidence and encoded knowledge. The basis of the proposed algorithm for the detection and identification of common cause failures is the use of functional diversity supplemented by additional plant condition information in situations where all direct redundant measurements may have failed or the specific evidence is not convincing. The inference process or decision estimator is based on a Bayesian formulation. The major conclusion of this study is that a properly implemented signal validation system using the proposed generalized decision estimator appears to provide successful protection against common cause failures in instrumentation and control systems. Specifically, it has been shown that implementation of signal validation using the generalized decision estimator could essentially eliminate a potentially important safety concern associated with the BWR vessel level instrumentation.

24826 Monitoring system for a liquid-cooled nuclear fission reactor. De Volpi, A. (to Dept. of Energy, Washington, DC). US Patent 4,649,015. 10 Mar 1987. Filed date 20 Jul 1984. vp.

This patent describes a fission reactor having a pressure vessel, a core in the pressure vessel, means for generating fission reaction heat in the core, and means including a coolant circulating under pressure through the reactor vessel and core for transmitting the heat to outside of the reactor for external conversion to useful work. An improved monitoring means is described for determining the level of the coolant at various regions in the reactor vessel, comprising the combination of gamma radiation detectors; means for positioning the radiation detectors adjacent the reactor vessel on the exterior side thereof. The radiation detectors are vertically spaced apart over the reactor vessel and the detectors are arranged in at least two sets, wherein each set of detectors is oriented radially to span different radially adjacent regions in the reactor to the exclusion primarily of the other sets; means for collimating each of the detectors to admit gamma radiation energy only along a limited substantially straight beam path; and means for detecting changes in the signals of the respective detectors and for apprising the corresponding changes in the level and density of the water proximate thereto.

2205 Environmental Aspects

REFER ALSO TO CITATION(S) 24831, 25833

24827 The current status of ARAC and its application to the Chernobyl event. Gudiksen, P.H.; Sullivan, T.J.; Harvey, T.F. (Lawrence Livermore National Lab., Atmospheric and Geophysical Sciences Div., P.O. Box 808, L-262, Livermore, CA 94550). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 584-589(Feb 1987). (CONF-861007—). Contract W-7405-ENG-48.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The Atmospheric Release Advisory Capability (ARAC) project, developed by the Lawrence Livermore National Laboratory (LLNL), provides real-time dose assessments and estimates of the extent of surface contamination that may result from an atmospheric release of radioactivity. It utilizes advanced computer-based data communication and processing systems to acquire the meteorological and source term information needed by the three-dimensional atmospheric dispersion models to derive the consequence assessments. The ARAC responded to the recent Chernobyl reactor accident in the Soviet Union by estimating the source term and the radiation dose distribution due to exposure to the radioactive cloud over Europe and the Northern Hemisphere. This analysis revealed that approximately 50% of the estimated core inventories of I-131 and Cs-137 were released. The estimated committed effective dose equivalent due to inhalation of radioactivity during cloud passage is of the order of 10 mrem within parts of Scandinavia and eastern Europe, while most of the populations within central Europe were exposed to levels ranging from 1-10 mrem. The amount of Cs-137 released by the Chernobyl accident far exceeds that released by previous reactor accidents, but is only about 6% of the Cs-137 produced by the atmospheric weapon testing programs.

2206 Research, Test, And Experimental Reactors

24828 (CONF-861185—11) The RERTR [Reduced Enrichment Research and Test Reactor] program: A progress report. Travelli, A. (Argonne National Lab., IL (USA)). Nov 1986. Contract W-31109-ENG-38. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006964.

From Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting; Gatlinburg, TN, USA (3 Nov 1986).

The progress of the Reduced Enrichment Research and Test Reactor (RERTR) Program is described. After a brief summary of the results which the RERTR Program, in collaboration with its many international partners, had achieved by the end of 1985, the activities, results, and new developments which occurred in 1986 are reviewed. The second miniplate series, concentrating on U_3Si_2-Al and U_3Si-Al fuels, was expanded and its irradiation continued. Postirradiation examinations of several of these miniplates and of six previously irradiated U_3Si_2-Al full-size elements were completed with excellent results. The whole-core ORR demonstration with U_3Si_2-Al fuel at 4.8 g U/cm^3 is well under way and due for completion before the end of 1987. DOE removed an important barrier to conversions by announcing that the new LEU fuels will be accepted for reprocessing. New DOE prices for enrichment and reprocessing services were calculated to have minimal effect on HEU reactors, and to reduce by about 8 to 10% the total fuel cycle costs of LEU reactors. New program activities include preliminary feasibility studies of LEU use in DOE reactors, evaluation of the feasibility to use LEU targets for the production of fission-product ^{99}Mo, and responsibility for coordinating safety evaluations related to LEU conversions of US university reactors, as required by NRC. Achievement of the final program goals is projected for 1990. This progress could not have been achieved without close international cooperation, whose continuation and intensification are essential to the achievement of the ultimate goals of the RERTR Program.

24829 (PB—87-151049/XAB) NBS (National Bureau of Standards) reactor: summary of activities July 1985 through June 1986. Technical note. Shorten, F.J. (National Bureau of Standards, Washington, DC (USA). Reactor Radiation Div.). Dec 1986. 166p. (NBS/TN—1231). NTIS, PC A08/MF A01.

See also report for Jul 81-Jun 82, PB—83-218636.

The report summarizes all those programs which depend on the NBS reactor. It covers the period from July 1985 to June 1986. The programs range from the use of neutron beams to study the structure and dynamics of materials through nuclear physics and neutron standards to sample irradiations for activation analysis, isotope production, radiation effects studies, neutron radiography, and nondestructive evaluation.

2209 Reactor Safety

REFER ALSO TO CITATION(S) 24792, 24803, 24804, 24814, 24825, 25475, 26001

24830 (BNL—38585) Team-enhanced evaluation method (TEEM) procedures: An enhanced human reliability analysis process. O'Brien, J.N.; Luckas, W.J. Jr.; Spettell, C.M. (Brookhaven National Lab., Upton, NY (USA)). Dec 1986. Contract AC02-76CH00016. 78p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87008375.

This report describes and documents the Team-Enhanced Evaluation Method (TEEM) for conducting an enhanced Human Reliability Analysis (HRA) of specific accident sequences at specific nuclear power plants. It is primarily meant to be used as a standalone tool to address Generic Safety Issues pertinent to human reliability in nuclear power plants. It is specifically designed so that it does have to be used in the context of a PRA, although its application to the human reliability part of a PRA is also recommended. The TEEM procedures lead to collection and analysis of data and information relevant to procedures, training, staffing, human engineering, management, and team communication. Further development of the TEEM procedures is recommended as a means of tying together and increasing the usefulness of several NRC-sponsored risk-related human reliability tools. 24 refs., 8 figs., 7 tabs.

24831 (BNL-NUREG—38549) A review of monitoring, sampling and analysis of reactor coolant, reactor containment atmosphere and airborne reactor effluents in post accident concentrations. Hull, A.P.; White, J.R.; Knox, W.H. (Brookhaven National Lab., Upton, NY (USA); Nuclear Regulatory Commission, King of Prussia, PA (USA). Region I; Knox Consultants, Inc., Dunwoody, GA (USA)). 1986. Contract AC02-76CH00016. 29p. (CONF-860820—13; CONF-8609147—12). NTIS, PC A03/MF A01 - GPO. File Number TI87006914.

From 19. DOE/NRC nuclear air cleaning conference; Seattle, WA, USA (17 Aug 1986).

A post-implementation review has been made in NRC Region I of the post-accident sampling systems (PASS), the gaseous effluent monitors, and the provisions for sampling effluent particulates and radioiodines which were required by the NRC subsequent to the TMI-2 accident (NUREG-0737). Prefabricated PASS systems were predominant. Problems included insufficient purge times, inadequate separation of dissolved gases, excessive dilution and the accuracy of analytical techniques in the presence of interferences. Microprocessor-controlled high-range gas monitors with integral provisions for sampling particulates and radioiodines in high concentrations were widely used. Calibration information was generally insufficient for the unambiguous conversion of monitor readings to release rates for a varying postaccident mixture of radiogases. The referenced sampling guidance (ANSI-N 13.1-1969) was inappropriate for the long sampling lines customarily used. Generic research is needed to establish the behavior of particulates and radioiodines in these lines.

24832 (CONF-860932—) ANS [American Nuclear Society] topical meeting on radiological accidents: Perspectives and emergency planning: Proceedings. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 357p. NTIS, PC A16/MF A01; 1; GPO Dep. File Number DE87007690.

From Radiological accidents, perspectives and emergency planning preparedness; Bethesda, MD, USA (15 Sep 1986).

The increasing use of radioactive materials and the increasing public concern about possible accidents involving these materials has led to greater emphasis on preparing for such emergencies. The ANS Topical Meeting on Radiological Accidents - Perspectives and Emergency Planning provided a review of experiences with radiological accidents. The meeting covered some of the most important aspects of radiological accidents. Papers were presented which dealt with radiological accident experience. Technical response to accidents is of primary interest to many in the nuclear community; most of the papers submitted fell into this area. So many of these papers dealt with the use of computers in response that a session on that topic was arranged. A very significant impact of most radiological accidents is the cost, especially the cost of cleanup. There were papers on what is known about costs and associated current topics, such as modification and extension of the Price-Anderson Act. At least as important as the technical response to accidents is how society attempts to deal with them. A session on institutional issues was included to discuss how governments and other organizations respond to and deal with accidents. Medical effects of accidents are of great concern to the public. Invited papers to review the effects of high doses of radiation as well as very low doses were included in that session. Although the nuclear industry has an excellent safety record, this fact often does not agree with the public perception of the industry. The final session explored the public response to and perception of radiological emergencies and accidents. This subject will ultimately determine the future use of radioactive materials in this country.

24833 (DOE/EH—0015) Technical safety appraisal of the N-Reactor. (USDOE Assistant Secretary for Environment, Safety and Health, Washington, DC. Office of Nuclear Safety). Jul 1986. 214p. NTIS, PC A10. File Number DE87004232.

This report presents the results of a Technical Safety Appraisal conducted at the Hanford N-Reactor. A team of specialists gathered information for about three weeks on all areas related to safety at the plant. Operational practices, maintenance practices, training drills, and hardware condition were observed. Several recommendations are made in order to correct incomplete rule implementation, to correct hazardous practices, and to promote improvement in satisfactory areas. (JDH)

24834 (EPRI-NP—5010) Application of leak-before-break analysis to PWR [pressurized water reactor] piping designed by Combustion Engineering: Final report. Ayres, D.J.; LaRussa, J.J.; Ganta, B.R.; Austin, S.C. (Combustion Engineering, Inc., Windsor, CT (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 93p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920300.

This program was conducted to develop guidelines by which pressurized water reactor piping systems other than main coolant piping can be evaluated in order to justify removal of currently required protective hardware. A survey of piping systems was performed on a generic basis to determine a prioritization for using the Leak-Before-Break (LBB) approach on different pipelines. Criteria pertaining to the LBB approach and to piping support optimization were examined. An evaluation of a sample pipeline was performed to demonstrate the methodologies used and considerations of criteria made to optimize its support system and to justify the elimination of its design basis pipe breaks. This report provides guidelines for using these methods of piping optimization, surveys piping systems for the use of the LBB approach, and presents a summary of the sample evaluation.

24835 (EPRI-NP—5025) Guidelines for designing fire protection systems for cable trays: Final report. Echternacht, J. (Impell Corp., Walnut Creek, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Jan 1987. 73p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920246.

This report describes a methodology for the design and specification of appropriate fire detection and suppression systems to protect cable trays in nuclear power plants. As a basis for determining the preferred fire protection systems to be used, the concept of the Damage Limit Option is introduced. Four Damage Limit Options are presented, each having a different level of acceptable damage based upon the required speed of detector and suppression system response. The design methodology includes guidance in the design of fire detection and water suppression systems. In addition, guidance is provided for the coordination of fire protection design with external organizations that specify requirements and internal organizations that design other plant systems. 24 refs., 10 figs., 4 tabs.

24836 (NUREG—0853-Suppl.8) Safety evaluation report related to the operation of Clinton Power Station, Unit No. 1 (Docket No. 50-461). (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Mar 1987. 56p. NTIS, PC A04/MF A01 - GPO. File Number TI87900581.

Supplement No. 8 to the Safety Evaluation Report on the application filed by Illinois Power Company, Soyland Power Cooperative, Inc., and Western Illinois Power Cooperative, Inc., as applicants and owners, for a license to operate the Clinton Power Station, Unit No. 1, has been prepared by the Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission. The facility is located in Harp Township, DeWitt County, Illinois. This supplement reports the status of items that have been resolved by the staff since Supplement No. 7 was issued.

24837 (NUREG—0876-Suppl.8) Safety evaluation report related to the operation of Byron Station, Units 1 and 2 (Docket Nos. STN 50-454 and STN 50-455). (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Mar 1987. 21p. NTIS, PC A02/MF A01 - GPO. File Number TI87900557.

Supplement No. 8 to the Safety Evaluation Report related to Commonwealth Edison Company's application for licenses to operate the Byron Station, Units 1 and 2, located in Rockvale Township, Ogle County, Illinois, has been prepared by th Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission. This supplement provides recent information regarding resolution of the license conditions identified in the SER. Because of the favorable resolution of the items discussed in this report, the staff concludes that the Byron Station, Unit 2 can be operated by the licensee at power levels greater than 5% without endangering the health and safety of the public.

24838 **(NUREG—1150-Vol.1) Reactor risk reference document: Main report: Draft for comment.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Feb 1987. 363p. NTIS, PC A16/MF A01 - GPO. File Number TI87900532.

The Reactor Risk Reference Document, NUREG-1150, provides the results of major risk analyses for five different US light-water reactors (Surry, Zion, Sequoyah, Peach Bottom, and Grand Gulf) using state-of-the-art methods. The broad base of probabilistic risk information contained in this document is intended to provide a data base and insights to be used in a number of regulatory applications. It is anticipated that these regulatory actions will include implementation of the NRC Severe Accident Policy Statement, implementation of NRC safety goal policy, consideration of the NRC Backfit Rule, evaluation and possible revision of regulations or regulatory requirements for emergency preparedness, plant siting, and equipment qualification, and establishment of risks-oriented priorities for allocating agency resources. This report has been published in draft form. For the plants analyzed, this document describes the major factors related to internally initiated events that contribute to severe core damage, frequencies and related uncertainty ranges of severe core damage events, the major factors and severe accident phenomena that could lead to containment failure, the conditional probabilities and uncertainty ranges of early containment failure, the consequences and risks of severe accidents, including the sensitivity of these risks to factors such as evacuation or sheltering measures, comparisons of the risks with NRC safety goals, and cost and risk-reduction analyses of plant-specific measures that could reduce risk from severe accidents.

24839 **(NUREG—1250) Report on the accident at the Chernobyl Nuclear Power Station.** (USDOE, Washington, DC; Electric Power Research Inst., Palo Alto, CA (USA); Environmental Protection Agency, Washington, DC (USA); Federal Emergency Management Agency, Washington, DC (USA); Institute of Nuclear Power Operations, Atlanta, GA (USA); Nuclear Regulatory Commission, Washington, DC (USA)). Jan 1987. 211p. NTIS, PC A10/MF A01 - GPO. File Number TI87005226.

This report presents the compilation of information obtained by various organizations regarding the accident (and the consequences of the accident) that occurred at Unit 4 of the nuclear power station at Chernobyl in the USSR on April 26, 1986. The various authors are identified in a footnote to each chapter. An overview of the report is provided. Very briefly the other chapters cover: the design of the Chernobyl nuclear station Unit 4; safety analyses for Unit 4; the accident scenario; the role of the operator; an assessment of the radioactive release, dispersion, and transport; the activities associated with emergency actions; and information on the health and environmental consequences from the accident. These subjects cover the major aspects of the accident that have the potential to present new information and lessons for the nuclear industry in general.

24840 **(NUREG—1260-Vol.1) A report to Congress on Nuclear Regulatory research: Project descriptions for FY87.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Feb 1987. 572p. NTIS, PC A24 - GPO. File Number DE87900558.

The report presents project descriptions of NRC research projects funded in Fiscal Year 1987. The individual project descriptions presented in this report are divided into six major groups of related projects. These groups, called issues, are as follows: Severe Accident, Risk and Reliability, Thermal Hydraulic Transients, Plant Aging and Life Extension, Seismic Research, and Waste Management. Within each issue, the project descriptions are further divided into subgroups, called subissues. An overview is provided prior to each issue and subissue giving a statement of the problem being addressed and the research objectives.

24841 **(NUREG/CR—3468) Hydrogen:air:steam flammability limits and combustion characteristics in the FITS [Fully Instrumented Test Site] vessel.** Marshall, B.W. Jr. (Sandia National Labs., Albuquerque, NM (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Reactor Systems Safety). Dec 1986. Contract AC04-76DP00789. 146p. (SAND—84-0383). NTIS, PC A07/MF A01 - GPO. File Number TI87007078.

For the past few years,the United States Nuclear Regulatory Commission has sponsored research at Sandia National Laboratories addressing the combustion characteristics and flammability limits of combustible atmospheres that might occur inside containment during a loss-of-coolant accident inside a pressurized water reactor (PWR). Combustion of certain hydrogen:air:steam atmospheres could, at least hypothetically, threaten the integrity of the containment structure. To assist in the resolution of these issues, a series of 239 hydrogen:air:steam combustion experiments was performed in a $5.6\ m^3$ vessel. Experimentally observed flammability limits of hydrogen:air:steam mixtures in both turbulent and quiescent environments were measured and a correlation developed that describes the three-component flammability limit. The newly developed correlation can be used to estimate the flammability of a mixture at these scales and larger scales to obtain approximate ignition conditions.

24842 **(NUREG/CR—4550-Vol.3) Analysis of core damage frequency from internal events: Surry, Unit 1.** Harper, F.T. (Sandia National Labs., Albuquerque, NM (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Reactor Systems Safety). Nov 1986. Contract AC04-76DP00789. 463p. (SAND—86-2084-Vol.3). NTIS, PC A20/MF A01 - GPO. File Number TI87007079.

This document contains the accident sequence analyses for Surry, Unit 1; one of the reference plants being examined as part of the NUREG-1150 effort by the Nuclear Regulatory Commission (NRC). NUREG-1150 will document the risk of a selected group of nuclear power plants. As part of that work, this report contains the overall core damage frequency estimate for Surry, Unit 1, and the accompanying plant damage state frequencies. Sensitivity and uncertainty analyses provide additional insights regarding the dominant contributors to the Surry core damage frequency estimate. The numerical results are driven to some degree by modeling assumptions and data selection for issues such as reactor coolant pump seal LOCAs, common cause failure probabilities, and plant response to station blackout and loss of electrical bust initiators. The sensitivity studies explore the impact of alternate theories and data on these issues.

24843 **(NUREG/CR—4696) Containment venting analysis for the Peach Bottom Atomic Power Station.** Hanson, D.J.; Blackman, H.S.; Nelson, W.R.; Wright, R.E.; Leonard, M.T.; DiSalvo, R. (EG and G Idaho, Inc., Idaho Falls (USA); Battelle Columbus Div., OH (USA)). Dec 1986. Contract AC07-76ID01570. 155p. (EGG—2464). NTIS MF A01 - GPO. File Number TI87007118.

The extent to which containment venting is an effective means of preventing or mitigating the consequences of overpressurization during severe accidents was evaluated for the Peach Bottom Atomic Power Station Units 2 and 3 (boiling water reactors with Mark I containments). Detailed analyses were conducted on operator performance, equipment performance, and the physical phenomenology for three severe accident sequences currently identified as being important contributors to risk. The results indicate that containment venting can be effective in reducing risk for several classes of severe accidents but, based on procedures in draft form and equipment in place at the time of the analyses, has limited potential for further reducing the risk for severe accidents currently identified as being important contributors to the risk for Peach Bottom.

24844 (NUREG/CR—4713) **Shutdown decay heat removal analysis of a Babcock and Wilcox pressurized water reactor: Case study.** Cramond, W.R.; Ericson, D.M. Jr.; Sanders, G.A. (Sandia National Labs., Albuquerque, NM (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Review and Oversight). Mar 1987. Contract AC04-76DP00789. 901p. (SAND—86-1832). NTIS MF A01- GPO. File Number TI87006736.

This is one of six case studies for USI A-45 Decay Heat Removal (DHR) Requirements. The purpose of this study is to identify any potential vulnerabilities in the DHR systems of a typical Babcock and Wilcox PWR, to suggest possible modifications to improve the DHR capability, and to assess the value and impact of the most promising alternatives to the existing DHR systems. The systems analysis considered small LOCAs and transient internal initiating events, and seismic, fire, extreme wind, internal and external flood, and lightning external events. A full-scale systems analysis was performed with detailed fault trees and event trees including support system dependencies. The system analysis results were extrapolated into release categories using applicable past PRA phenomenological results and improved containment failure mode probabilities. Public consequences were estimated using site specific CRAC2 calculations. The Value-Impact (VI) analysis of possible alternatives considered both onsite and offsite impacts arriving at several risk measures such as averted population dose out to a 50-mile radius and dollars per person rem averted. Uncertainties in the VI analysis are discussed and the issues of feed and bleed and secondary blowdown are analyzed.

24845 (NUREG/CR—4742) **MELPROG-PWR [pressurized water reactor] MOD1 analysis of a TMLB′ accident sequence.** Kelly, J.E.; Henninger, R.J.; Dearing, J.F. (Sandia National Labs., Albuquerque, NM (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Reactor Systems Safety). Jan 1987. Contract AC04-76DP00789. 84p. (SAND—86-2175). NTIS, PC A05/MF A01 - GPO. File Number TI87006737.

The first complete, coupled, and mechanistic analysis of a reactor core meltdown sequence has been made with MELPROG-PWR/MOD1. The sequence analyzed was a station blackout accident sequence (TMLB′) for the Surry plant. The MELPROG calculation was initiated at the point where boiling began in the vessel and was run through the point that the reactor vessel failed. Between the beginning and the end, all important aspects of the meltdown sequence were calculated with MELPROG. This version of MELPROG permits a full two-dimensional treatment of the in-vessel phenomena. As such, the important effects of in-vessel natural circulation can be accurately modeled. To assess the importance of natural circulation and other two-dimensional effects, the current calculation was compared with one-dimensional MELPROG and MARCH calculations of the same accident scenario. This comparison shows that natural circulation reduces the rate of core heating, but increases the rate of heating of upper plenum structures. This implies that a significant amount of the core energy is deposited in the plenum and primary piping. This increased heating can inhibit fission product deposition and may lead to an early failure of the primary system. Hence, natural circulation alone can completely change the course of a meltdown sequence (relative to one-dimensional calculations). Limited sensitivity studies were performed to assess the relative importance of various modeling assumptions. One of the key models assessed was the modeling of the initial fuel rod melting and relocation. Variations in the modeling assumptions were found to strongly affect hydrogen production and the subsequent course of the accident. The magnitude of hydrogen source could be varied by a factor of two through variations in fuel rod modeling. This result implies that accurate and mechanistic modeling is important for severe accident sequence analysis.

24846 **Review of operating experience on engineered safety features actuating systems.** Meyers, L.C. (Idaho National Engineering Lab., EG and G Idaho Inc., P.O. Box 1625, Idaho Falls, ID 83415). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 576-579(Feb 1987). (CONF-861007—). Contract AC07-76ID01570.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Operating experience with the Engineered Safety Features Actuating System (ESFAS), as reported in the Nuclear Power Experiences data base, and selected plant records, is presented. The purpose of this study is to evaluate the potential significance of aging, including cycling, trips, and testing as contributors to degradation of the ESFAS. Tables are presented that show the percentage of failure events classified by component, subcomponent, and cause for boiling water reactors and pressurized water reactors. A representative engineered safeguards actuating channel was selected for detailed study. Functional indicators of degradation and testing requirements are evaluated.

24847 **Aging system interaction studies: In-depth engineering studies of selected systems.** Jacobs, P.T. (Idaho National Engineering Lab., EG and G Idaho, Inc., P.O. Box 1625, Idaho Falls, ID 83415). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 558-561(Feb 1987). (CONF-861007—). Contract AC07-76ID01570.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

A research program sponsored by the U. S. Nuclear Regulatory Commission to investigate the aging impact on nuclear plant safety is described. The program progress to date is summarized and plans for FY-1987 and beyond are discussed.

24848 **Singular perturbation analysis of relaxation oscillations in reactor systems.** Ward, M.E.; Lee, J.C. (Bettis Atomic Power Lab., P.O. Box 79, West Mifflin, PA 15122). *Nuclear Science and Engineering;* **95**: No. 1, 47-59(Jan 1987).

A singular perturbation method for the analysis of large power oscillations in nuclear reactors is applied to obtain phase-plane solutions of the Ergen-Weinberg model. The system equations, recast in an appropriate form, directly give a first approximation to the closed trajectory in which the system behaviour is idealized as relaxation oscillations. Further approximations in the phase plane are determined using separate perturbation series on individual parts of the oscillation, with variations in the assignment of dependent and independent variables to consistently obtain convergent series. The accuracy of each order of the phase-plane solution increases with the magnitude of the power pulse in the actual physical situation. For realistic reactor conditions, both the trajectory and period of oscillation are well predicted using the first two terms of each perturbation series.

24849 **Sodium Advanced Fast Reactor (SAFR) for safe economic power.** Brunings, J.E.; Guenther, E.; Hren, R. (Rockwell International, Canoga Park, CA). *Proceedings of the American Power Conference;* **48**: 683-687(Apr 1986). (CONF-860422—).

From American power conference; Chicago, IL, USA (14 Apr 1986).

The team of Rockwell International, Combustion Engineering, and Bechetel is developing the Sodium Advanced Fast Reactor (SAFR) as one element in the United States Department of Energy's Advanced Liquid-Metal Reactor (LMR) program. The SAFR plant concept employs a 350-MWe pool-type LMR Power Pak as its basic module. The Power Pak is a standardized, shop-fabricated unit that can be shipped to the plant site by barge for installation. Shop fabrication minimizes nuclear-grade (ASME Section III) field fabrication and reduces the plant construction schedule. Power Pak module can be used individually or in multiples at a given site to supply the needed electrical capacity.

24850 **Investigation of intergranular stress corrosion cracking in the fuel pool at Three Mile Island Unit 1.** Czajkowski, C.J. (Brookhaven National Lab., Upton, NY). pp 205-214 of Corrosion cracking. Goel, V.S. Metals Park, OH; American Society for Metals (1985). (CONF-851203—).

From International conference and exhibition on fatigue, corrosion cracking, fracture mechanic and failure analysis; Salt Lake City, UT, USA (2 Dec 1985).

An intergranular stress corrosion cracking failure of 304 stainless steel pipe in 2000 ppm B as H/sub 3/BO/sub 3/ + H/sub 2/O at 100°C has been investigated. Constant extension rate testing has produced an intergranular type failure in material in air. Chemical analysis was performed on both the base metal and weld material, in addition to fractography, EPR testing and optical microscopy in discerning the mode of failure. Various effects of Cl/sup -/, O/ sub 2/ and MnS are discussed. The results have indicated that the cause of failure was the severe sensitization coupled with probable contamination by S and possibly by Cl ions.

24851 Large break LOCA analyses: Upper plenum injection vs. downcomer injection. Dobranich, D. (Sandia National Labs., Thermal/Hydraulic Analysis Div.). pp 7.D1-7.D6 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—). Contract AC04-76DP00789.

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

TRAC-PF1 was used to simulate the thermal-hydraulic response of a two-loop pressurized water reactor (PWR) during a postulated 200% guillotine break in one of the cold legs. Two modes of low pressure pumped injection of emergency core cooling (ECC) liquid were investigated: upper plenum injection and downcomer injection. Upper plenum injection is the mode currently used for two-loop plants, whereas downcomer injection more closely simulates the assumption that ECC liquid is delivered directly to the lower plenum. Two different input models were used for these investigations: an "integral" model containing a relatively coarse-node vessel and a "detailed" model containing a detailed three-dimensional vessel.

24852 A TRAC-PF1/MOD-1 analysis of Loss-of-Fluid Test L9-4. Meier, J. (Los Alamos National Lab., Los Alamos, NM 87545). pp 7.H1-7.H8 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

Los Alamos National Laboratory is developing the Transient Reactor Analysis Code (TRAC) to provide advanced best-estimate predictions of postulated accidents in pressurized water reactors (PWRs) and for many thermal-hydraulic experimental facilities. As part of our independent assessment of code version TRAC-PF1/MOD1. The authors analyzed Loss-of-Fluid Test (LOFT) L9-4 and compared the test data to the calculated results. This was an anticipated-transient-without-scram (ATWS) test in which the pumps were tripped, the steam generator main feedwater discontinued, and the main steam-outlet valve closed. This data comparison is the first extensive test of TRAC's reactor-kinetics models. The comparisons show that TRAC can calculate the power generation within a nuclear reactor if the program generation within a nuclear reactor if the program is supplied with adequate reactor-kinetics input specifications.

24853 TRAC-PF1/MOD 1 posttest analysis of semiscale small-break test S-UT-8. Fujita, R. (Los Alamos National Lab., Los Alamos, NM 87545). pp 7.I1-7.I8 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

A posttest analysis of Semiscale Small-Break Test S-UT-8 was performed with the Transient Reactor Analysis Code (TRAC). TRAC code version PF1/MOD1 was assessed with the experiment data. Semiscale Test S-UT-8 simulated a non-upper-head injection. 5% small-break loss-of-coolant accident (SBLOCA) in a Westinghouse-type pressurized water reactor (PWR). TRAC-PF1/MOD1 adequately predicted all of the phenomena experienced in the test, such as, primary-system depressurization, loop seal clearance, liquid holdup in the upflow-side of the steam generators, core liquid depression, and recovery, and core quenching. This analysis illustrates the importance of properly predicting the mass distribution of the system to obtain good comparison with the Semiscale data.

24854 Evaluation of BWR emergency procedure guidelines for BWR ATWS using RAMONA-3B code. Neymotin, L.; Slovik, G.; Cazzoli, E.; Saha, P. (Brookhaven National Lab., Upton, NY 11973). pp 3.D1-3.D11 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

An MSIV Closure ATWS calculation for a typical BWR/4 (Browns Ferry, Unit 1) was performed using the RAMONA-3B code which is a BWR systems transient code combining three-dimensional neutronic core representation with multi-channel one-dimensional thermal hydraulics. The main objective of the study was to perform a best-estimate evaluation of the recently proposed Emergency Procedure Guidelines for Anticipated Transients Without Scram (ATWS). Emphasis was placed on evaluating the effects of lowering the downcomer water level to the Top of Active Fuel (TAF) and vessel depressurization.

24855 RAMONA-3B/MINET composite representation of BWR thermal-hydraulic systems. Van Tuyle, G.J.; Slovik, G.; Cazzoli, E.G.; Nepsee, T.C.; Guppy, J.G. (Brookhaven National Lab., Upton, NY 11973). pp 3.C1-3.C7 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

The modification and interfacing of two computer codes, RAMONA-3B and MINET, for the thermal hydraulic transient analysis of a Boiling Water Reactor nuclear steam supply system, is described. The RAMONA-3B code provides for multi-channel thermal hydraulics and three-dimensional (or one-dimensional) neutron kinetics analysis of a boiling water reactor core. The RAMONA-3B system representation terminates at the end of the steam line and at the junction of the feedwater line at the vessel inlet. By interfacing RAMONA-3B with MINET, a generic balance-of-plant systems analysis code, a complete BWR systems code with detailed core modeling was obtained. The result is a code of particulate importance to the analysis of transients such as ATWS.

24856 Flow visualization study of inverted annular flow of post dryout heat transfer region. Ishii, M.; De Jarlais, G. (Argonne National Lab., Argonne, IL 60439). pp 1.C1-1.C8 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

The inverted annular flow is important in the area of LWR accident analysis in terms of the maximum cladding temperature and effectiveness of the emergency core cooling. However, the inverted annular flow thermal-hydraulics is not well understood due to its special heat transfer condition of film boiling. In view of this, the inverted flow is studied in detail experimentally. A new experimental apparatus has been constructed in which film boiling heat transfer can be established in a transparent test section. Data on liquid core stability, core break-up mechanism, and dispersed-core liquid slug and droplet sizes are obtained using F 113 as a test fluid. Both high speed movies and flash photographs are used.

24857 Los Alamos PWR feed-and-bleed studies: Summary results and conclusions. Boyack, B.E.; Henninger, R.J.; Lime, J.F. (Energy Div., Los Alamos National Lab., Los Alamos, NM 87545). pp 7.J1-7.J8 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

The adequacy of shutdown decay heat removal in pressurized water reactors (PWRs) is currently under investigation by the Nuclear Regulatory Commission. One part of this effort is review of feed-and-bleed procedures that could be used if the normal cooling mode through the steam generators was unavailable. The feasibility of the feed-and-bleed concept as a diverse mode of heat removal has been evaluated at the Los Alamos National Laboratory. The TRAC-PF1 code has been used to predict the expected performances of the Oconee-1 and Calvert Cliffs-1 reactors of Babcock and Wilcox and Combustion Engineering, respectively, and the Zion-1 and H. B. Robinson-2 plants of Westinghouse.

24858 **Analytical comparison of loss-of-flow transient performance for carbide- and oxide-fueled small LMFBRs.** Rothrock, R.B.; Morgan, M.M.; Baars, R.E. (Los Alamos National Lab., Los Alamos, NM 87545). pp 12.G1-12.G5 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

The study described in this paper was limited to the initial (coastdown) phase, where core design features such as the selection of the fuel system can play the greatest role. It included overall system transient calculations to establish core transient boundary conditions (flow, power, inlet temperature); steady state and transient thermal-hydraulic calculations for individual fuel assembly models; and finally, an estimate of the extent of core damage, using fuel pin transient performance models.

24859 **Analysis of multiple-tube ruptures in both steam generators for the Three Mile Island-1 pressurized water reactor.** Nassersharif, B. (Los Alamos National Lab., Los Alamos, NM 87545). pp 11.B1-11.B7 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

Steam generator tube-rupture (SGTR) transients have recently drawn much attention because of their frequency of occurrence and potential severity. One area of interest has been multiple-tube rupture. Multiple-tube rupture in both steam generators (SGs) is a severe accident sequence that could result in a need to isolate both SGs and to initiate a primary-system feed-and-bleed operation. As part of an ongoing Nuclear Regulatory Commission (NRC)-sponsored SGTR program at Los Alamos, the authors investigated a low probability multiple-tube-rupture event in both SGs of the Three Mile Island Unit 1 (TMI-1) pressurized water reactor (PWR) with the Transient Reactor Analysis Code (TRAC).

24860 **Hand calculational techniques in reactor safety analysis.** Driskell, W.E.; Larson, J.R. (Idaho National Engineering Lab., EG and G Idaho, Inc., Idaho Falls, ID 83415). pp 11.D1-11.D6 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—). Contract AC07-76ID01570.

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

The Three Mile Island incident identified a need for the U.S. Nuclear Regulatory Commission (USNRC) to improve its nuclear incident response capabilities. Based upon a study conducted by EG&G Idaho, Inc. it was determined that simple hand calculational aids can be developed to assist USNRC personnel to follow and project reactor conditions during an accident. This paper presents one such aid developed for an accident scenario resulting from a loss of all ac power.

24861 **Considerations for realistic ECCS evaluation methodology for LWRs.** Rohatgi, U.S.; Saha, P.; Chexal, V.K. (Brookhaven National Lab., Upton, NY 11973). pp 8.I1-8.I13 of Proceedings of third international topical meeting on reactor thermal hydraulics. Chiu, C.; Brown, G. La Grange Park, IL; American Nuclear Society (1985). (CONF-851007—).

From 3. international meeting on reactor thermal hydraulics; Newport, RI, USA (15 Oct 1985).

This paper identifies the various phenomena which govern the course of large and small break LOCAs in LWRs, and affect the key parameters such as Peak Clad Temperature (PCT) and timing of the end of blowdown, beginning of reflood, PCT, and complete quench. A review of the best-estimate models and correlations for these phenomena in the current literature is presented. Finally, a set of models is recommended which may be incorporated in a present best-estimate code such as TRAC or RELAP5 in order to develop a realistic ECCS evaluation methodology for future LWRs and have also been compared with the requirements of current ECCS evaluation methodology as outlined in Appendix K of 10CFR50.

24862 **Finite element quasi-Eulerian method for three-dimensional fluid-structure interactions.** Kulak, R.F. (Argonne National Lab., IL). *Computers and Structures;* **18**: No. 2, 319-332(1984).

A quasi-Eulerian approach is used in the development of a three-dimensional hydrodynamic finite element. With this approach the motion of the computing grid may be different from the motion of the material. Within each element the field variables are represented by trilinear interpolation functions and the pressure field is assumed to be constant. This leads to a set of simple relations for internal nodal forces that are easily coded and computationally efficient. Because the formulation is based upon a rate approach it is applicable to problems involving large displacements. The technique of degeneration is applied to the hexahedron to generate a pentahedral element. The use of the hour-glass dissipating nodal-forces for mesh stabilization is discussed. The procedure used to couple the fluid and structural domains of a problem is presented. The above method is applied to a three-dimensional, fluid-structure interaction problem in the area of reactor safety. 24 references, 22 figures, 2 tables.

25 ENERGY STORAGE

2505 Flywheels

REFER ALSO TO CITATION(S) 24863

2506 Thermal

24863 **(ORNL/TM—10194) Application of thermal and flywheel energy storage in orbiting nuclear burst power systems.** Wichner, R.P.; Olszewski, M. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 115p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007882.

A survey was conducted of currently available thermal energy storage and flywheel energy storage technology and development programs as they may apply to nuclear-based, burst power systems. The manner in which such storage systems may be used in closed cycle, regenerable burst systems is described for a number of cases utilizing the Boiling Potassium Rankine and Dual Loop Lithium Cooled LMRs and the Direct Cycle Brayton HTGR. In general, energy storage devices for such systems enable use of smaller power system components by allowing continuous operation over the duration of both the bursts and the regeneration time. The degree of size reduction depends principally on the required regeneration time.

2508 Chemical

24864 **(RISO-M—2609) Safety evaluation of magnesium hydride in energy storage.** Vigeholm, B. (Risoe National Lab., Roskilde (Denmark)). Sep 1986. 49p. (In Danish). NTIS (US Sales Only), MF A01. File Number DE87751683.

Investigations of the magnesium/magnesium hydride system and its potential in energy storage have been carried out at Risoe National Laboratory for some years. The results of this research indicate that the system is technically feasible, at least in some applications. The lack of available information of the hazards involved in handling magensium hydride powder might however be a serious barrier to implementation. In this work a series of experiments relevant to handling and storage of magnesium hydride is reported. With a comparable magnesium powder as reference 100 - 400 g hydride powder was ignited under various conditions and the temperature in and over the powder mass recorded. Also the probable reaction of powder with water was investigated. The general conclusion is that magnesium hydride reacts in a very similar way to magnesium and should be handled accordingly, allowing though for the potential release of hydrogen during non-combusting heating.

2509 Batteries

REFER ALSO TO CITATION(S) 25173

24865 **(AD-A—176212/9/XAB) Study into the effect of humidity on (PEO)8.$LiCf_3SO_3$ solid-polymer electrolyte. Technical report, 15 July 1985-30 December 1986.** Munshi, M.Z.; Owens, B.B. (Minnesota Univ., Minneapolis (USA). Corrosion Research Center). Jan 1987. 19p. NTIS, PC A02/MF A01.

A-c impedance measurements were made on a number of (PEO)8.LiCF3SO3 polymeric electrolytes subjected to different levels of humidity stored up to 5 days. Arrhenius plots indicate that there is a decrease in the conductivity with increasing levels of humidity. However, this effect appears to be reversible and the material can regain its original conductivity somewhat upon heating.

24866 **(AD-A—176214/5/XAB) Performance and safety testing of lithium batteries for the expendable, mobile, ASW training target (EMATT). Technical document.** Hallal, P.B.; Bis, R.F. (Naval Underwater Systems Center, Newport, RI (USA)). 1 Aug 1986. 30p. (NUSC-TD—6502). NTIS, PC A03/MF A01.

The developmental EMATT (expendable, mobile, ASW training target) may use a high-energy (lithium/sulfuryl chloride) battery system. Safety problems with the original battery cell design were experienced during early performance and safety testing. After redesign of the battery cell, performance and safety tests were made under specified abuse conditions, as well as under simulated launch conditions. The test results showed that the power system now meets all safety requirements, and that the EMATT vehicle is safe to deploy for its engineering development phase.

24867 **(AD-A—176235/0/XAB) Solid-state lithium/polyacetylene battery. Technical report No. 4, 15 July 1985-30 December 1986.** Scrosati, B.; Owens, B.B. (Minnesota Univ., Minneapolis (USA). Dept. of Chemical Engineering and Materials Science). Jan 1987. 12p. NTIS, PC A02/MF A01.

A solid-state lithium/iodine battery was formed by directly contacting metallic lithium with iodine-doped polyacetylene. The procedure is similar to that used for the well-known lithium/iodine-polyvinylpyridine system. The advantage of the system here proposed may be related to the extraordinary electrical properties of polyacetylene which, when doped with iodine, acquires a very high electrical conductivity over a wide range of halogen concentration.

24868 **(AD-A—176237/6/XAB) Solid-state batteries. Technical report No. 1, 15 July 1985-30 December 1986.** Munshi, M.Z.; Owens, B.B. (Minnesota Univ., Minneapolis (USA). Dept. of Chemical Engineering and Materials Science). Jan 1987. 14p. NTIS, PC A02/MF A01.

The all solid-state battery has been an idealized technological goal because of the assumption that the problem of batteries containing liquid phases are, at least in part, due to the fluid properties that can lead to high rates of self discharge, leakage of electrolyte through battery seals, and poor performance at both extremes of temperatures due to phase transitions. The major problem in developing useful solid-state batteries has been to identify solid-state ionically conducting materials with adequate conductivity to serve as the battery electrolyte. Recent work on new glasses and new polymer electrolytes have stimulated this field of investigation.

24869 **(AD-A—176283/0/XAB) History of solid-state batteries. Technical report, 15 July 1985-30 December 1986.** Owens, B.B.; Munshi, M.Z. (Minnesota Univ., Minneapolis (USA). Corrosion Research Center). Jan 1987. 4p. NTIS, PC A02/MF A01.

Historically, batteries have combined liquid electrolytes with solid electrodes because solid electrolytes were to resistive and could not accommodate the volumetric changes associated with the cell reactions. Solid materials utilized as battery electrolytes include: 1) simple ionic salts - silver iodide; 2) double salt compounds - rubidic silver iodide; (3) dispersed phase solid electrolytes - LiI $(AL_2)_3$); (4) ceramic compounds - Sodium - Beta - $Al_2)_3$; 5) in-situ formed electrolytes - lithium iodide; 6) glasses - $LiI\text{-}Li_2S\text{-}P_2S_5$; 7) polymer electrolytes - (PEO)8$LiCLO_4$). Commercialization has been limited because of performance and cost factors.

24870 **(DOE/ET/26923—T4) Design, assembly, qualification, and testing of a 500-kWh, 100-kW zinc-chloride battery system for the BEST Facility: Final report.** (Energy Development Associates, Greensboro, NC (USA)). 1983. Contract AC02-78ET26923. 159p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87007935.

The DOE-EDA program was in four phases, as follows: Component Development, Prototype Battery Qualification, 500-kWh Battery Assembly and Qualification, and 500-kWh Battery Assembly and Qualification, and 500-kWh Battery Test at BEST Facility. The initial 30 baseline cycles were accumulated at an availability of 91% and a corresponding capacity of 94%. The final 50 cycles of the test program were devoted to an evaluation of system performance under conditions anticipated in utility and customer-side-of-the-meter (CSOM) service. These included load leveling, peak shaving, full-reversal area regulation, mass transit and industrial-mill peaking, and spinning reserve. During this test program, which concluded November 16, 1984, the energy delivered by the battery system exceeded 50 MWh dc. This successful test resulted in recommendations for technology improvements in the following areas: PVC formulation; sensor encapsulation; shorting switches; and gear pumps.

24871 **(LBL—22705) An investigation of zinc electrodes relevant to zinc-air batteries.** Choi, H.S. (California Univ., Berkeley (USA)). Dec 1986. Contract AC03-76SF00098. 83p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007607.

The particulate electrode (fluidized bed electrode or moving bed electrode) has been studied to evaluate its possible application to energy storage. The first part of this study is concerned with the effect of current fluctuation on the morphology of zinc electrodeposited on the rotating disc electrode from alkaline zincate electrolyte. The effect of the fluctuation on the morphology was examined by scanning electron microscopy. The deposits under the condition of fluctuating current density were smoother than those formed under constant current density. The second part is concerned with the electrodeposition of zinc from alkaline electrolyte with the cell employing a fluidized bed electrode which simulates the recharge process of the secondary battery employing a particulate electrode. Except at high current density, energy consumption per unit production was less than 3 to 4 kWh/kg which is the characteristic value of conventional electrowinning from acidic solution. A laboratory cell with a particulate zinc electrode and an air counter electrode was constructed and discharge characteristics were studied to evaluate the cell. Energy efficiencies during discharge at 5 and 2.5A were about 20 and 30% respectively.

24872 **(N—87-16445) Initial performance of advanced designs for IPV nickel-hydrogen cells.** Smithrick, J.J. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Sep 1986. 13p. (NASA-TM—87282; E—2992; NAS—1.15:87282; CONF-860913—3). NTIS, PC A02/MF A01.

From International power sources symposium; Brighton, UK (8 Sep 1986).

Advanced designs for individual pressure vessel nickel-hydrogen cells have been conceived which should improve the cycle life at deep depths-of-discharge and improve thermal management. Features of the designs which are new and not incorporated in either of the contemporary cells (Air Force/Hughes, Comsat) are: (1) use of alternate methods of oxygen recombination, (2) use of serrated edge separators to facilitate movement of gas within the cell while still maintaining required physical contact with the wall wick, and (3) use of an expandable stack to accommodate some of the nickel electrode expansion. The designs also consider electrolyte volume requirements over the life of the cells, and are fully compatible with the Air Force/Hughes design.

24873 **Glass corrosion in ambient temperature lithium battery headers.** Bunker, B.C.; Douglas, S.C.; Quinn, R.K. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Materials Research;* **2**: No. 2, 182-194(Mar 1987).

During high-temperature storage, glass corrosion in glass-to-metal feedthroughs can limit the lifetimes of lithium batteries designed to operate at ambient temperatures. Ampule tests have been conducted to simulate glass corrosion for Li/So$_2$, Li/SOCl$_2$, and Li/SOCl$_2$+BrCl batteries. In all lithium battery systems tested, lithium metal has been identified as the source of glass corrosion. On the basis of thermodynamic and kinetic stability, glass compositions have been developed that minimize the corrosion problem in all lithium battery systems tested.

24874 **Zirconia-toughened sodium beta"-alumina solid electrolyte.** Olson, D.; De Jonghe, L.C. (Lawrence Berkeley Lab., CA, USA; California Univ., Berkeley, USA. Dept. of Materials Science and Mineral Engineering). *Journal of Materials Science;* **21**: No. 12, 4221-4226(Dec 1986).

The effect of a 15 vol% zirconia dispersion on the critical current density for failure initiation of beta"-alumina solid electrolyte was examined. Single phase and composite electrolytes were tested in standard sodium-sodium test cells and subjected to increasing ionic currents. Onset of degradation in the electrolyte was detected by monitoring acoustic emissions from the cell. Preliminary examination of the electrolyte material showed that the problem of producing a uniform dispersion of zirconia in pure beta"-alumina had not been solved. However, the electrolytes were of sufficient quality to draw important conclusions about the potential of transformation toughening for improving electrolyte performance.

24875 **Improved methods for achieving the equilibrium number of phases in mixtures suitable for use in battery electrodes e.g., for lithiating** FeS$_2$. Guidotti, R.A. US Patent Application 6-872,728. 10 Jun 1986. 35p. Contract AC04-76DP00789. DE87007189 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007189.

A method is disclosed for preparing lithiated, particulate FeS$_2$ useful as a catholyte material in a lithium thermal battery, whereby the latter's voltage regulation properties are improved. The method comprises admixing FeS$_2$ and an amount of a lithium-containing compound, whereby the resultant total composition falls in an invariant region of the metallurgical phase diagram of its constituent components. Said lithium-containing compound and FeS$_2$ are admixed together with a solid electrolyte compatible with said catholyte, and the mixture is heated at a temperature above the melting point of said electrolyte and at which said mixture reaches its thermodynamic equilibrium number of phases.

24876 **Method for improving voltage regulation of batteries, particularly Li/FeS$_2$ thermal batteries.** Godshall, N.A. (to Dept. of Energy). US Patent Application 6-872,718. 10 Jun 1986. 44p. Contract AC04-76DP00789. DE87007188 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007188.

Batteries are improved, especially with respect to voltage regulation properties, by employing as anode and cathode compositions, those which fall in a thermodynamically invariant region of the metallurgical phase diagram of the combination of the constituent components. The invention is especially useful in the Li/FeS$_2$ system.

24877 **Charge transfer between polypyrrole coated n-Si electrodes and solid polymer electrolytes.** Skotheim, T.A.; Inganas, O. (Brookhaven National Lab., Upton, NY). *Molecular Crystals and Liquid Crystals;* **121**: 285-289(1985). Contract AC02-76CH00016.

The authors developed photoelectrochemical cells based on rectifying junctions between n-Si and thin film polymer solid electrolytes. The authors describe various surface modifications applied to the n-Si electrodes which overcome a high activation energy barrier for efficient charge transfer to redox ions in the polymer solid electrolytes. 6 references, 3 figures.

29 ENERGY PLANNING AND POLICY

REFER ALSO TO CITATION(S) 25097, 25098, 25100

2901 Energy Analysis And Modeling

REFER ALSO TO CITATION(S) 24951, 24952

24878 (DOE/CE/27460—T4, pp 129-143) **Dialectic of cooperation: how the Hood River project worked.** Peach, H.G.; Oliver, T.V.; Cherniack, M.; Goldstein, D.; Philips, M. (Pacific Power & Light, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

Energy policy planning in the Pacific Northwest has been characterized by controversy and factionalism since the early 1970s. The Hood River Conservation Project, a $21 million empirical test of residential retrofit conservation, was guided by a consensus-driven steering committee, the Regional Advisory Group. This group was primarily composed of seven organizations whose interaction illustrates the cooperative process. The focus of this paper is the usefulness of the consensus model. The paper also shows the application of argument maps, as a tool that an be used by planners, utility managers, and evaluators. Three specific problems that arose in project research planning, weatherization operations, and interpretation of empirical findings are discussed. Two are illustrated by argument maps in this paper. The problems encountered within the project are problems typical to evaluation research in an organizational context. Conclusions about inter-organizational cooperation in a consensus-driven evaluation program are presented. 16 references, 3 figures, 1 table.

24879 **(ESC—39) The reprogramming of the energy model SELPE in the modelling language GAMS.** Van Oostvoorn, F.; Van Arkel, W.G.; De Lange, A.V.M. (Stichting Energieonderzoek Centrum Nederland, Petten. Energie Studie Centrum). Dec 1986. 105p. (In Dutch). NTIS (US Sales Only), PC A06/MF A01. File Number DE87751769.

In the past five years a large scale linear programming (LP) energy model called SELPE (Static ESC linear programming energy model) was developed. Initially this model was built for the development of in-house software tools. Since the model became more complex, the modifications and extensions of the model for new policy studies grew more and more cumbersome, costly and error-prone, reason why reprogramming of the energy model SELPE in the modelling language GAMS (General algebraic modelling system) is developed at the World Bank. A comprehensive overview is given of the way the LP model SELPE is programmed and can be used in GAMS. First a brief description of GAMS is presented. Next the major elements such as the nodes and flows of the energy network are discussed. Furthermore the complete model, including equations and additional programs, is presented. The appendices contain a more detailed description of the GAMS software, particularly useful as an users guide.

24880 **(NP—7751714) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.5: Price development for space heat as reflected by the expected cost of primary energy to the year 2000.** Geipel, Z. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). 1983. 143p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE87751714.

As a contribution to investigations on possibilities of meeting energy requirement by sources other than heating oil (supply concept) in the Rhine and Neckar region, this report deals with the price development for space heat as reflected by the expected cost of primary energy to the year 2000. A forecast of the development of energy consumption is first of all given for petroleum, coal, nuclear energy, natural gas and renewable energies, and the world energy situation is considered. That forecast, and a retrospective are then extended to cover also the Federal Republic of Germany, and continued to the year 2000. The publication gives figures for confirmed and probable world stocks and points out how new sources to be made available and stock-keeping of primary energy sources are to be evaluated. The employment viewpoint is considered and the dependence on energy imports referred to. The burden on the national economy from the use of different energy sources is described as well as the suitability of energy sources for being processed and converted. Finally it is asked how harmful external influences on the national economy can be averted and freedom to make political decisions preserved. (HWJ).

24881 LBL residential energy model an improved policy analysis tool. McMahon, J.E. (Lawrence Berkeley Lab., CA). *Energy Systems and Policy;* **10**: No. 1, 41-72(1987). Contract AC03-76SF00098.

Energy consumption in residences accounts for 20% of total energy and 35% of electricity used in the United States today. Over time, the amount of energy consumed to provide a particular service will change. The mix of fuels consumed also changes; recently, households have increased their electricity consumption and decreased consumption of fossil fuels. For these reasons, an understanding of the components of residential energy consumption is important to utility companies and government policy makers. This article describes the development of the LBL Residential Energy Model to provide improved policy analysis at the end-use level. The major improvements include:representation of recent equipment efficiency trends; new techniques for forecasting future appliance efficiencies and annual appliance replacements; and extension of the model to include heat-pump space-conditioning systems. The resulting forecasts give improved agreement with recently reported energy consumption and provide lower estimates of future energy consumption.

2902 Economics And Sociology

REFER ALSO TO CITATION(S) 24501, 24637, 24640, 24650, 24651, 24682, 24683, 24696, 24908, 24918, 24921, 24948, 24953, 25862

24882 (DOE/BP/13837—T1) Springfield/L-COG energy plan implementation program internal energy management project: Final report. (Lane Council of Governments, Eugene, OR (USA)). Sep 1985. Contract FG79-83BP13837. 70p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007811.

The Internal Energy Management Project was developed as a component of the Springfield/L-COG Energy Plan Implementation Program. The project also took advantage of the ground work laid by the Lane Council of Governments through the Lane County Electric Energy Planning Program. This program, conducted in 1982 and 1983, developed detailed recommendations for Lane County cities concerning energy management and planning. Based on these recommendations, many jurisdictions committed themselves to implement energy management programs. Initially, the participating cities included Springfield, Veneta, Oakridge, Creswell, and Lowell. Two other local governments - Florence and Lane County - requested assistance once the project commenced.

24883 (PB—87-143541/XAB) State energy price and expenditure data system, 1970-1984. Data file. Lay, C.L. (USDOE Energy Information Administration, Washington, DC). 1984. vp. NTISCP T02.

Supersedes PB—86-181096; Source tape is in the EBCDIC character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. Call NTIS Computer Products if you have questions.

The State Energy Price and Expenditure Data System (SEPEDS) data base contains annual energy price, consumption, and expenditure estimates for 1970 through 1984. Consumption information used for developing the expenditures estimates are derived from the State Energy Data System (SEDS) file that covered 1960-1984. The public-use tape contains three standard IBM type files. The first file on the tape is a copy of this document. The second file on the tape is the source code for a Table Producing Language (TPL) codebook. TPL is a language designed for quickly and easily producing cross tabulations. The tables in the publication were generated with TPL, and if the user's system supports TPL, this may provide convenient access to the data. Both of these machine readable files are provided for your convenience. The data base is the third file. This file contains 15,392 records of 225 characters. Appendix C contains a file description with specific data location on the record.

2903 Environment, Health, And Safety

REFER ALSO TO CITATION(S) 24499, 24685, 25179, 25772, 25773, 25776, 25812, 25838, 25860, 25862, 26181

24884 (PB—87-129839/XAB) Southeast Chicago study: an assessment of environmental pollution and public-health impacts. Final report. D'Auben, D. (Illinois Environmental Protection Agency, Springfield (USA). Environmental Programs). Mar 1986. 332p. (IEPA/ENV—86-008). NTIS, PC A15/MF A01.

Southeast Chicago, in the vicinity of Lake Calumet, is a heavily industrialized region that has a long history of serving as a disposal area for a wide variety of industrial, commercial, and residential wastes. In the late fall of 1982, the Illinois Environmental Protection Agency (IEPA) was asked by a citizens group, Irondalers to Abolish the Chemical Threat (I-ACT), to conduct a study of environmental pollution in this area with special emphasis directed toward waste-disposal practices. The final scope of work included a broad range of environmental concerns relating to air, water, and land pollution issues. This scope of work was reviewed and approved by the I-ACT liaison committee. Additionally, as part of the overall effort, an analysis of available health statistics was performed by the Illinois Department of Public Health (IDPH) to determine if cancer rates or the number of birth defects occurring in the area are unusual. The report summarizes the results of these study efforts.

24885 (PB—87-143095/XAB) Linkages of atmospheric, aquatic, and terrestrial environments: a review of multimedia models. Open file report. Cardamone, M.A.; Mitsch, W.J. (Louisville Univ., KY (USA)). Dec 1985. 76p. NTIS, PC A05/MF A01.

The report identifies and reviews some major attempts that have been made to develop multimedia models for the management of air, land, water, and groundwater resources. A multimedia model is defined here as a model that explores the action of a pollutant not only into, but through, more than one medium. Multimedia models are classified as fate and transport models, effects models, assessment models, and management and planning models. Fate and transport models are further classified as composite, fully coupled, and compartmental models. Twenty-five multimedia models from all of these categories are reviewed and summarized; several other models that could be coupled with other models to create multimedia models are also presented. Conclusions on the state of the use of modeling are presented, particularly in reference to the Federal Government's role in environmental management.

24886 (PB—87-145017/XAB) Registry of toxic effects of chemical substances, 1983 supplement to the 1981-82 edition. Volumes 1 and 2. Lewis, R.J.; Sweet, D.V. (Tracor JITCO, Inc., Rockville, MD (USA)). Oct 1984. 1708p. NTIS, PC A99.

See also cumulative supplement to 1981-82 edition, PB—87-145033, and Volume 1, 2, and 3 dated June 83, PB—85-218071.

This is the twelfth edition of the Registry of Toxic Effects of Chemical Substances (RTECS). The publication is a 2-volume 1983 Supplement to the 1981-82 Edition of the RTECS. RTECS is intended to provide basic information on the known toxic and biological effects of chemical substances to employers, employees, physicians, industrial hygienists, toxicologists, researchers, and anyone else with the need to know in order to assure proper and safe handling of chemicals. This Supplement contains 18,893 prime name chemical substances with their associated toxicity data. For these entries, 93,263 synonyms are included as cross references. All prime name listings are either new entries to the file or contain changes in the data from the last edition (1981-82).

24887 (PB—87-145033/XAB) Registry of Toxic effects of Chemical Substances, 1983-84 cumulative supplement to the 1981-82 edition. Volumes 1 and 2. Lewis, R.L.; Sweet, D.V. (Advanced Engineering and Planning Corp., Inc., Rockville, MD (USA)). Nov 1985. 2110p. NTIS, PC A99.

See also supplement to 1981-82 edition, PB—87-145017, and Volumes 1, 2 and 3 dated June 83, PB—85-218071.

This is the thirteenth edition of the Registry of Toxic Effects of Chemical Substances (RTECS). This publication is a 2-volume 1983-84 Supplement to the 1981-82 Edition of the RTECS. RTECS is intended to provide basic information on the known toxic and biological effects of chemical substances to employers, employees, physicians, industrial hygienists, toxicologists, researchers, and anyone else with the need to know in order to assure proper and safe handling of chemicals. This Supplement contains 26,341 prime chemical substances with their associated toxicity data. For these entries, 113,211 synonyms are included as cross-references. All prime name listings are either new entries to the file or contain changes in the data from the 1981-82 Edition.

24888 (PB—87-146007/XAB) Technologies for in-situ treatment of hazardous wastes. Sanning, D.E.; Lewis, R.F. (Environmental Protection Agency, Cincinnati, OH (USA). Hazardous Waste Engineering Research Lab.). Jan 1987. 28p. (EPA—600/D-87/014). NTIS, PC A03/MF A01.

This paper gives a general overview/problem definition and state-of-the-art of the natural processes of biodegradation and chemical transformations. The importance and problems of delivery and recovery systems are emphasized. In-situ treatment technologies are classified into extraction processes (air stripping, flushing, freezing, electrokinetics, vegetative and thermal) and immobilization and degradation processes (grouting, fixation, thermal fusion, chemical and biological). Documented case histories of an in-situ treatment at several sites are presented. This will include some of the ongoing and completed EPA/ORD activities.

24889 (UCRL—94614) Organoleptic water quality: Health and economic impacts. Daniels, J.I.; Layton, D.W.; Nelson, M.A.; Olivieri, A.W.; Cooper, R.C.; Danielson, R.E.; Bruvold, W.H.; Scofield, R.; Hsieh, D.P.H.; Schaub, S.A. (Lawrence Livermore National Lab., CA (USA); California Univ., Berkeley (USA); California Univ., Davis (USA); Army Medical Bioengineering Research and Development Lab., Fort Detrick, MD (USA)). Feb 1987. Contract W-7405-ENG-48. 9p. (CONF-870586—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87007332.

From International conference on resource mobilization for drinking water supply and sanitation in developing nations; San Juan, Puerto Rico (26 May 1987).

Organoleptic properties of drinking water (i.e., characteristics perceptible to the senses) can affect the acceptance of water by the public. In this paper we present a risk-analysis methodology, along with supporting data, that can be used for assessing the relationship between the level of either (1) turbidity, color, and odor; or (2) total dissolved solids (TDS); or (3) metabolites of algae and associated bacteria in drinking water, and the fraction of an exposed population that could reject the water. We explain how this methodology can be used by public health authorities in developing nations as a rational approach for adopting pragmatic water-quality guidelines for these organoleptic constituents, and for accurately correlating concentrations of these organoleptic constituents with the need to commit manpower and resources to improve water quality in rural areas, small communities, and large cities.

2904 Natural Resources

REFER ALSO TO CITATION(S) 24719

24890 (NP—7751720) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Subsection A.1: Compilation of literature data on the present state of knowledge on energy resources, the state of the art of energy conversion systems, and development trends. Kalkum, B. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). Jul 1982. 193p. (In German). NTIS (US Sales Only), PC A09/MF A01. File Number DE87751720.

In the framework of investigations on how to meet energy demand by energy sources other than heating oil in the Rhine and Neckar region, excerpts of literature were compiled on the current state of knowledge on energy resources as well as on the state-of-the-art of energy conversion systems and their development prospects. Consideration regarding the geological presence of, and technical and economic possibilities for extracting, fossile energy feedstocks relate to coal stock, world coal trade, coal deposits, trade, and consumption in the Federal Republic of Germany as well as to coal production and supply (extraction and treatment cost, cost of coal gasification and coal liquefaction, transport cost and distribution cost). Furthermore information is provided as to the possibilities for using coal (gasification, liquefaction), also inferior quality products, and problems of future availability and use of coal are pointed out. Similar considerations are then entered upon regarding petroleum, natural gas, nuclear fuels and renewable energy sources (solar energy, wind energy, energy production from biomass, geothermal energy). Finally the development of the world's energy requirement and possible ways of meeting it are described, and forecasts are made regarding the prices of primary energy sources and their supply costs for the period of investigation. (HWJ).

2905 Research, Development, Demonstration, And Commercialization

REFER ALSO TO CITATION(S) 24757, 24895, 24922, 25430, 25479, 26361, 26383

24891 (DOE/EIA—0173(86)) Annual report to Congress, 1986. (National Energy Information Center, Washington, DC (USA)). 18 Feb 1987. 61p. NTIS, PC A04/MF A01 - GPO; 1; GPO Dep. File Number DE87006840.

The following section of this report highlights some of EIA's accomplishments in 1986, followed by a sampling of typical EIA data. Finally, this report contains three appendices. Appendix A lists EIA's 1986 survey forms and gives a brief illustration of the kinds of data collected by each form. Appendix B describes the models used by EIA. Appendix C lists all EIA reports published during the year.

24892 (DOE/ER—0192/2) Technology '86: Technology Transfer Program: Annual report. (USDOE Office of Energy Research, Washington, DC. Laboratory Management Div.). Jan 1987. 82p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87005219.

Technology transfer accomplishments are reported in the following areas: energy technologies, biology and medicine, environment and waste management, computers and communications, analysis and instrumentation, and materials science and manufacturing processes. (DLC)

24893 (ORNL/TM—9695) Materials project of the Energy Conversion and Utilization Technologies (ECUT) program for Fiscal Year 1983: Annual progress report. Morris, L.E.; Jordan, A.; Carpenter, J.A. Jr. (Oak Ridge National Lab., TN (USA)). Feb 1987. Contract AC05-84OR21400. 98p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007791.

This is the annual technical progress report for fiscal year 1983 of the Materials Project of the US Department of Energy (DOE) Energy Conversion and Utilization Technologies (ECUT)

Program. In fiscal year 1983, the ECUT Materials Project conducted research in four technical areas, or "work elements," entitled High Temperature Materials, Lightweight Materials, Materials by Design, and New Assessments and Initiatives. The progress of the various tasks of the work elements is discussed in this report.

2906 Nuclear Energy

REFER ALSO TO CITATION(S) 24610, 24618, 24637, 24639, 24640, 24650, 24651, 24654, 24793, 24806, 24811, 26361

24894 (CONF-8510420—1) China's Nuclear Power Program: Options for the US. Suttmeier, R.P. (Woodrow Wilson International Center for Scholars, Washington, DC (USA). Asia Program). 1985. Contract FG01-82PE70399. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004155.

From United States/East Asian energy security seminar; Washington, DC, USA (16 Oct 1985).

The issue of American nuclear cooperation with the People's Republic of China is examined with regards to political relations, commercial benefits to the United States, and nonproliferation. China's interest in nuclear power is examined, and its nuclear program is briefly reviewed from the 1950's to present. China's international nuclear relations with other countries are discussed, and implications for the United States examined, particularly with regards to China's intentions toward nuclear proliferation, danger of diversion of material for nuclear weapons, use of pressurized water reactor technology for Chinese naval reactors, and the terms of the nuclear cooperation agreement. (LEW)

24895 The status of nuclear fusion research. Yoshikawa, S. (Princeton Plasma Physics Lab., Princeton). pp 117-122 of Global energy assessment and outlook. Kursunoglu, B.N.; Perlmutter, A.; Scott, L. New York, NY; Harwood Academic Pub. (1984).

The author summarizes the status of nuclear fusion research as follows: scientific feasibility of a fusion reactor can be demonstrated in 3-6 years; large scale (future) experiments are needed to test engineering problems, etc., possibly in 1990; economical questions are becoming important. There are two aspects: the energy cost must be sufficiently low (absolute), and the fusion reactor cost should be competitive with indigenous energy sources (relative); and possible alternatives to improve the economical aspects of a CTR must be explored.

24896 United States domestic and international nuclear policies established under the Reagan administration. Rusche, B. (United States Dept. of Energy). pp 111-116 of Global energy assessment and outlook. Kursunoglu, B.N.; Perlmutter, A.; Scott, L. New York, NY; Harwood Academic Pub. (1984).

Key aspects of the U.S. National Energy Policy Plan (NEPP) which set the stage for specific approaches in the nuclear area are discussed. These aspects are as follows: (i) NEPP shows faith in domestic energy production (including nuclear power) and in the supply side of the economy generally; (ii) It supports elimination of unnecessary regulation; (iii) It reorients Federal spending on energy research and development and reduces support in areas that can better be performed in the private sector. However, it does not signal an end to Federal support for R&D on energy technology of the future in areas where a combination of financial risks and long lead times fail to attract adequate commercial investment; (iv) It foresees the demand for electricity as probably rising more rapidly in the future than overall U.S. energy demand, which in combination with high oil prices will increase the desirability of shifting to cheaper means of generating electricity. (v) It is broader in scope than the activities of the Department of Energy and involves the cooperation of other U.S. government agencies which have important roles to play in the U.S. energy economy.

24897 Breeder reactor in the US: a new economic analysis. Bupp, I.C.; Derian, J. (Harvard Univ., Cambridge, MA). *Technology Review;* 26-36(Jul-Aug 1974).

The authors address two main issues concerning the economics of the breeder reactor program: is there a need to extend uranium resources; and can electricity be produced more cheaply by breeder reactors than by LWR reactors? They conclude that, because of ample reserves in the US, the future supply of uranium is a question of cost and time scale rather than availability. The overall cost of electricity produced by breeders is a matter of considerable uncertainty and depends primarily on the cost of uranium in the future.

2907 Transport And Storage

24898 (NP—7751717) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.2: Energy transport. Chapter A.4.2.3. District heat transport. Kalkum, B.; Troszkiewicz, J. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). Nov 1982. 246p. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751717.

In the framework of a comparative analysis of the use of the alternative energy sources gas, electricity and district heat, more precise data are provided regarding district heat transport. The investigated possibilities for such district heat transport over larger distances constitute conventional systems with ideal flow and reflux pipes; a two-pipe system (heat pump installation, reflux pipe without thermal insulation); one-pipe system (heat pump, water heated in the thermal power plant); system of 'cold district heat'; transport system (transport by rail or ship). With the various alternative transport possibilities for district heat, some items touched on are the following: annual continuous curves, calculation bases, breaking up of heat output, heat generation cost, temperature conditions, water treatment, transport nets and cost functions as a function of flux temperature with and without heat pump. The detailed descriptions of the individual district heat transport sectors are completed by diagrams and tables containing information on the individual alternative sectors. (HWJ).

2908 Waste Heat Utilization

REFER ALSO TO CITATION(S) 24539, 24697, 24905, 24907

24899 (TVA/OP/CEM—87/53) Statistical analysis: The 1986 farm energy survey of the Tennessee Valley. Camp, W.A. (Tennessee Valley Authority, Chattanooga (USA). Div. of Conservation and Energy Management). [1987]. 63p. NTIS MF A01. File Number DE87900616.

In October 1986, the NASS of the USDA conducted 1200 personal interviews with Valley farmers for TVA. This survey was designed to provide estimates of energy use and program participation in TVA's energy conservation and load management programs. This report summarizes the results of the personal interviews and serves as an addendum to the previously released "Down On the Farm" report. Additional background and methodology information is located in Appendix A. Three main sections comprise the body of this report. The first section, "Awareness, Participation, and Interest Levels in Existing and Future TVA Energy Services," analyzes the farmers' awareness and participation rates in comparison to the rates for all Valley-Wide residential consumers. The second section, "Energy Usage on the Farm," provides estimates of total fuel mix based upon different agricultural end-uses. The last section, "Demographics and Farm Characteristics," provides detail information on the Valley-wide farmer and his farmstead.

2910 Conservation

REFER ALSO TO CITATION(S) 24526, 24878, 24918, 24944, 24949, 24973, 24991, 24992, 24993, 24994, 24995, 24996, 24997, 24998, 24999, 25000, 25001, 25002, 25003, 25004, 25005, 25015, 25048, 25049, 25050, 25053, 25059, 25060, 25062, 25063, 25065, 25066, 25067, 25068, 25069, 25070, 25071, 25140, 25168, 25216, 25217

24900 (DOE/CE/64780—T8) Institutional conservation program: Energy use data base demonstration: Final report. (Unified Industries, Inc., Springfield, VA (USA)). Apr 1987. Contract FG01-84CE64780. 66p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87008187.

An attempt was made to motivate implementation of energy accounting programs in seven states. None of the seven states initiated a systematic statewide accounting program. The principal reason was lack of personnel. The project strategy was reformed to disseminate information to all states and territories and to other interested organizations. Recipients of the reports greeted them positively and expressed interest in energy accounting. However, there is no evidence that any state or local government instituted an energy accounting program because of the reports. The project was again reformed to attempt to demonstrate the initiation of an energy accounting service. Prison inmates who were students in computer classes could provide data processing and handling. Officials in New York State explored the possibility of starting, at Attica Correctional Facility, an energy accounting service to serve public buildings in New York.

24901 (DOE/CH/10225—1) Program management support to the institutional conservation program: Final report. Azad, B.; Poston, P.R.; Walsh, J.H. (B and M Technological Services, Inc., Cambridge, MA (USA)). Dec 1985. Contract AC02-84CH10225. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008019.

Between October 1, 1984 and December 31, 1985, B and M Technological Services, Inc. (B and M) provided support services in conjunction with the Institutional Conservation Program (ICP). The ICP is a grant program for the states and certain eligible institutions (primarily schools and hospitals) to assist in administering and funding energy conservation projects. These projects range from studies of building energy use conducted by engineers and architects to actual acquisition and installation of equipment and materials to improve the efficiency of energy use in selected buildings. This document represents the final report on compliance monitoring of ICP grants under two separate contracts.

24902 (DOE/CH/10225—2) Program management support to the Institutional Conservation Program: Review of Cycle VII grant applications: Final report. Azad, B.; Poston, P.R.; Bradshaw, D.S. Jr. (B and M Technological Services, Inc., Cambridge, MA (USA)). Dec 1985. Contract AC02-84CH10225. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008247.

The Institutional Conservation Program (ICP), which was established under the authority of the National Energy Conservation Policy Act (NECPA) of 1978, Title III, is funded in annual cycles. The Department of Energy (DOE), Boston Support Office (BSO), administers the Program in the six New England states. The technical review of grant applications is an integral part of the administration of the Program in this Region. This Final Report covers grant application review activities during the period October 1, 1984 through December 31, 1985. It includes statistical information on the number and types of grants, grant budgets and number of buildings funded in each state; a discussion and comments on the quality of Cycle VII applications; and recommendations and suggestions for potential improvements to the grant application review process and the overall quality of applications.

24903 (GB—57) Energy conservation II. Second report by the SOLACE Energy Conservation Panel. (Society of Local Authority Chief Executives (SOLACE), Northampton (UK)). 1985. 59p. British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

A booklet has been prepared to assist Chief Executives in their oversight of energy conservation in their local authorities. Following an introductory chapter on energy trends and prospects, several aspects of energy conservation are covered including energy management in a local authority, the current energy conservation opportunities available to local authorities, current research and development, examples of savings achieved in local authority, energy conservation case studies, a list of information sources for the Energy Manager in the Authority, training and staff matters, energy conservation incentive schemes and finally energy saving programmes in the European Community.

24904 (NP—7751730) Energy conservation - are policies to be left in the hands of the public utilities - the transferability of the US models to Austria ('Tennessee Valley Authority'). Glatz, H.; Hein, W. (comps.). (Oesterreichischen Arbeiterkammertages, Vienna. Inst. fuer Wirtschaft und Umwelt). Jan 1985. 21p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751730.

The US electric utilities and in particular the Tennessee Valley Authority have meanwhile been starting to finance energy conserving measures contributing to the fulfillment of their contract binding them to provide for public energy supplies. The model has come up for discussion in Austria. From the point of view of energy policy there is nothing economically unreasonable about the idea of choosing the cheapest supply system (in other words, the weighing of power generation against energy conservation). A basic discussion is followed by an explanation of the two countries' differing decors.

2920 Supply, Demand, And Forecasting

REFER ALSO TO CITATION(S) 24526, 24529, 24880, 24944, 24945, 24947

24905 (DOE/EIA—0202(87/1Q)) Short-term energy outlook: Quarterly projections, January 1987. (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). 19 Feb 1987. 49p. NTIS, PC A03/MF A01 - GPO; 1; GPO Dep. File Number DE87007557.

The three projections for petroleum supply and demand are based on low, middle, and high crude oil price trajectories. The discussion and tables in this volume refer primarily to the middle, or base case, scenario and, unless otherwise noted, to the domestic situation. Other cases examining the sensitivity of total petroleum demand to varying assumptions about prices, weather, and economic activity are shown in Table 13 on page 40. Discussions of the world oil price refer to the cost of imported crude oil to US refiners.

24906 (NP—7751716) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section B.9: Heat consumption data of all communities of the area under investigation. Guenter, Z.D. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). 1983. 47p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE87751716.

In the framework of investigations regarding possibilities of meeting energy requirement by sources other than heating oil (supply concept), 345 localities were analysed in the Rhine and Neckar region. Four categories were formed ranging from communities with more than 10,000 inhabitants to ones with 2,000. For settlement types ST 1 to ST 11, thermal engineering data were compiled in very comprehensive tables (heat requirement of 1980, with and without thermal protection; heat requirement for the state of the building in the year 2000, with additional thermal protection). The thermal engineering data are explained individually; hints are given as to heat output requirements (with and without thermal protection) of the individual communities (space heating, service water heating). The years of reference are 1980 and 2000. The 33 communities studied are mentioned by name. (HWJ).

24907 **(NP—7751722) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.2: Load conditions for a satisfied heat demand. Subsection A.2.2. Energy demand and waste heat recovery in industrial plants.** Bartholomaei, G. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). Jul 1982. 271p. (In German). NTIS (US Sales Only), PC A12/MF A01. File Number DE87751722.

This two-part contribution to investigations on the substitution of alternative energy sources for heating oil in the Rhine and Neckar region deals with load conditions in case of satisfied heat demand as well as with energy requirement and the possibility for using waste heat in industry. It establishes the energy requirement of the most important branches of industry in the area of investigation and points out their most important thermal engineering processes (temperature level, furnaces, processes: basic materials and production goods industry, investment and consumer goods industry, foodstuff and luxury foodstuff industries). Curves for energy requirement are shown. The second part of the report provides data on the economic efficiency of waste heat utilization measures, a heat exchanger and a waste heat exchanger, as well as a heat exchanger for recovering waste heat from products, vapours, sewage water and off-air. Furthermore the report describes the energy requirement and possibilities of using waste heat in selected industrial undertakings in the area of investigation. (HWJ).

24908 **(PB—87-928500/XAB) Economic and energy indicators. Bi-weekly report.** (Central Intelligence Agency, Washington, DC (USA)). 1987. vp. NTISStanding Order.

Supersedes PB—86-928500; Paper copy available on Standing Order, Deposit Account required. North American Continent price based on page count of individual documents; all others write for quote. This series offers a reduction in price as a Standing Order. Single copies also available.

The EEI provides up-to-date information on changes since 1977 in economic and energy activities of major countries. It consists of tables only. They depict (a) economic indicators (industrial production, unemployment, consumer price inflation, and exchange rate trends) for the Big Seven developed countries (United States, Japan, West Germany, France, United Kingdom, Italy, and Canada); (b) foreign trade and foreign trade prices for the Big Seven; and (c) monthly average prices for selected agricultural products and industrial materials. The energy indicators include tables on petroleum consumption, production, and imports for the Big Seven. A table and chart depict the movement of OPEC average crude oil sales prices since 1973.

2930 Policy, Legislation, And Regulation

REFER ALSO TO CITATION(S) 24520, 24610, 24639, 24640, 24654, 24685, 24895, 24896, 24921

24909 **(CONF-8511268—1) An American energy agenda for the Pacific.** Randolph, R.S. (Woodrow Wilson International Center for Scholars, Washington, DC (USA). Asia Program). 20 Nov 1985. Contract FG01-82PE70399. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004154.

From U.S.-East Asian energy security seminar; Washington, DC, USA (20 Nov 1985).

It is by now a well-recognized fact that the Pacific Basin has become a major world center of economic growth. Definitions of what constitutes the "Pacific Basin" vary, but here I am referring to the free market nations comprising the arc extending from Korea and Japan down through Taiwan, Hong Kong, the ASEAN countries, and Australia and New Zealand. Increasingly, I would include the People's Republic of China in that economic definition, as its economy continues to modernize and to move in more open, market-oriented directions. Though not yet caught up in the same processes of economic growth, the small island states of the South Pacific should also be considered part of that broader economic fabric. This continued pattern of development has significant implications for the United States. It is no secret that exports by Pacific countries account for a major portion of the current US trade deficit. It is less well understood that Asia also constitutes a major market for the US. Japan is currently the United States' largest overseas market, and other Asia-Pacific states are major importers of US agricultural and other goods. Unites States energy exports are also an integral component of many of the United States' key trading relationships in the region. While fundamentally commercial in nature, these exports occur at a significant level and are therefore a matter of direct interest to the US government, which frequently plays a positive, supporting role.

24910 **(DOE/PE/77035—T2) International energy cooperation: The mismatch between IEA policy actions and policy goals: [Final report].** Smith, R.T. (Claremont McKenna Coll., CA (USA). Center for the Study of Law Structures). [1985]. Contract FG01-85PE77035. 121p. NTIS MF A01; 2; GPO Dep. File Number DE87006038.

This analysis discusses the link, if any, between IEA policy actions and stated goals of the Program. Understanding the reasons for success or failure of IEA actions identifies which policies achieve real gains from international energy cooperation, and which are counterproductive. Section I is an overview of the structural framework of the IEA. Section II describes the institutional and organizational background, including the policy mechanisms, of the IEA. Section III looks at specific policy actions undertaken by the agency, particularly during the Iranian revolution and at the outbreak of the Iran-Iraq War. The economic consequences of oil sharing are examined in section IV, which simulates a world oil supply disruption affecting IEA member countries differentially. Section V analyzes import controls, focusing on coordination problems and possible OPEC pricing responses, and examines the actual record of general petroleum consumption restraints in 1980. Oil stockpiling is analyzed both as a general economic phenomenon and an object of IEA coordination in section VI, which also offers an econometric analysis of actual experience in the 1970s and 1980s. Section VII considers a number of less formal assessments of IEA policies, including self-evaluations by the IEA itself.

24911 **(DOE/PE/77035—T3) Oil import quotas in the context of the International Energy Agency sharing agreement: [Final report].** Horwich, G.; Miller, B.A. (American Enterprise Inst. for Public Policy Research, Washington, DC; California Univ., Berkeley (USA)). [1987]. Contract FG01-85PE77035. 65p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006123.

A requirement of the IEA oil sharing agreement is that, during disruptions, countries whose actual oil supplies exceed their supply rights eliminate the gap by reducing consumption. If, as described in chapter 2 and alluded to in chapter 3, the reduction is implemented by an import quota, the resulting "kink" in the world demand for imports could, under noncompetitive market conditions, cause the world price of oil to rise. No serious assessment of the emergency programs of the IEA can ignore this possible perverse outcome of oil sharing. The Emergency Sharing System does not require countries to impose quotas but in fulfilling a supply limitation prescribed by the ESS, countries will almost inevitably be forced to employ quotas rather than tariffs. The reason for this is the fact that the supply right is expressed as a quantitative consumption limit. The natural policy response is thus to specify the quantitative import ceiling that exactly meets the limit. A tariff is, of course, an addition to price that may or may not reduce imports exactly to the desired level. Altering the tariff in a trial and error attempt to bring imports precisely to the ceiling is almost certainly not a feasible course of action. Governments will have a second reason for preferring quotas to tariffs as a means of meeting their ESS obligation. In the first instance, both instruments will raise the effective domestic price of oil - tariffs, by simply being added to the prevailing price; quotas, by creating a value in the right or license to import oil. A rise in the effective price of oil will always be unpopular, but particularly so in the context of a disruption and the price rise already associated with it. An effective further price rise reflecting the right to import oil under a quota, however, is less likely to be associated by the public with past or present governmental policies than is a direct further rise due to a tariff.

24912 **(DOE/PE/77035—T4) Coordinated stock drawdowns: Pros and cons: [Final report].** Weyant, J.P. (American Enterprise Inst. for Public Policy Research, Washington, DC; Stanford Univ., CA (USA). Energy Modeling Forum). 9 Jun 1986. Contract FG01-85PE77035. 30p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006212.

Plans are readied in case a supply disruption reoccurs. There is one significant difference between the oil market today and that of the 1970s. The amount of oil now in government-mandated and government-held stockpiles is large enough to mitigate the sudden price increases and other adverse effects of oil-supply interruptions. Stockpiled oil can be substituted for the lost oil supply and, consequently, provides a direct antidote for the upward pressure on oil prices. This makes oil stockpiles highly credible policy tools. To be effective, it is important for large stock releases to occur as soon after a major oil supply interruption begins as possible. This creates the need for coordination. The fungible nature of oil guarantees that oil released anywhere reduces the effective size of any shortfall, decreasing the price paid for oil everywhere. If one country releases stocks, it reduces the price of oil to all countries buying oil on the world market; if other countries release stocks as well, the price of oil to the first country will be further reduced.

24913 **(DOE/PE/77035—T5) Restructuring the IEA crisis-management program to better serve member country interests: [Final report].** Bohi, D.R.; Toman, M.A. (American Enterprise Inst. for Public Policy Research, Washington, DC; Resources for the Future, Inc., Washington, DC (USA)). Feb 1986. Contract FG01-85PE77035. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006213.

Starting from the premise that securing the gains from international energy cooperation requires a milieu in which positive action will be taken, not just a narrow economic analysis of benefits and costs, this paper examines ways in which the crisis-management system of the International Energy Agency (IEA) could be strengthened to better serve members' self-interests. The benefits of stockpile coordination are found to be potentially substantial but difficult to achieve because of disparities in members' interests. A "mixed" agreement is recommended, with primary emphasis on stockpiling by the United States and demand restraint by other IEA countries. Such an approach, while theoretically inferior to stockpile coordination, is more compatible with members' interests and thus capable of achieving success.

24914 **(DOE/PE/77035—T6) Empirical analysis of world oil trade: 1967-1984: [Final report].** Anderson, J.M. (American Enterprise Inst. for Public Policy Research, Washington, DC; ICF, Inc., Washington, DC (USA)). Dec 1986. Contract FG01-85PE77035. 57p. NTIS MF A01; 2; GPO Dep. File Number DE87006238.

In this chapter the author examines the world oil market over the period 1967-1984 in an effort to evaluate its relative performance during periods of normal and disrupted supply. The author first examines and compares import prices and quantities among major oil importing countries in order to determine whether any country was disproportionately affected by supply disruptions. This analysis includes the construction of import price indices adjusted for oil quality changes. Second, he analyzes the demand for oil imports to determine whether import levels of various countries during supply disruptions can be explained adequately by the same factors that operate during nondisrupted periods.

24915 **(DOE/PE/77035—T7) An analysis of the International Energy Agency: Comments by a sometime practitioner: [Final report].** Cooper, R.N. (American Enterprise Inst. for Public Policy Research, Washington, DC; Harvard Univ., Cambridge, MA (USA)). [1986]. Contract FG01-85PE77035. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006605.

The papers of this volume contain two, by Smith and by Badger, that offer an overall evaluation of the IEA. They offer radically different assessments. Smith is unremittingly hostile, arguing that the IDA did no good under any heading, and strongly suggesting that it actually destabilized the oil market. Badger in contrast reasserts the traditional rationale for the IEA in terms of macroeconomic externalities, terms of trade effects, and the free rider problem, and gives a cautiously positive appraisal, but with much less supporting analysis than Smith offers. The author is closer to Badger in his appraisal, but Smith has provided a detailed analysis supporting his evaluation, and it deserves careful examination. The remaining four papers are less broad in scope, each focusing on a particular aspect of International Energy Policy. Horwich, Jenkins-Smith, and Weimer provide a quantitative appraisal of a stylized oil sharing scheme on the assumption of a given temporary shortfall in oil production and a given drawdown of oil stocks. They conclude that allowing the price to clear the market is superior to alternative methods of allocation, except when terms of trade gains may compensate for efficiency losses in other allocation schemes.

24916 **(DOE/PE/77035—T8) International cooperation during oil supply disruptions: The role of the International Energy Agency: [Final report].** Badger, D.B. Jr. (American Enterprise Inst. for Public Policy Research, Washington, DC; Putnam, Hayes and Bartlett, Inc., Newton, MA (USA)). [1987]. Contract FG01-85PE77035. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87004970.

In fulfillment of its mandate, the IEA's work has evolved in several directions, the most important of which are information systems, promotion of long-term policies, and emergency response. The Agency's emergency response programs are detailed. As with the other areas of activity, the emergency programs have evolved considerably since their initial formulation in 1974. This evolution reflects both the structural change in the oil market since that time, as well as lessons learned from actual oil market events and from simulated tests of supply disruptions. With its "coordinated stockdraw" decision of July 1984, the IEA Governing Board strongly supplemented the 1974 "emergency sharing" agreement, though this remains a major component of the overall emergency response plan.

24917 **Evolution of energy planning in Liberia.** Neufville, M.; Barron, W.F.; Koshel, P. (National Energy Committee, Monrovia, Libera). *Energy Systems and Policy;* **10**: No. 2, 149-166(1987). Contract AC05-84OR21400.

Recent evaluations of the energy planning experience in developing countries suggest that the foremost challenge is linking energy analysis effectively with energy policymaking and implementation. This paper described an attempt to improve the institutional setting for energy planning in one developing country, Liberia. Although any single model of energy planning should be used with considerable caution, given the many ways in which each nation's context for policymaking is to some degree unique, they suggest that Liberia's experience offers useful lessons for other countries and donor institutions. 13 references, 1 table.

24918 **Energy planning for development: Needs and approaches.** Mubayi, V. (International Energy Studies Group, National Center for Analysis of Energy Systems, Brookhaven National Lab.). pp 455-466 of Global energy assessment and outlook. Kursunoglu, B.N.; Perlmutter, A.; Scott, L. New York, NY; Harwood Academic Pub. (1984).

This paper examines the acquisition of greater capability in one important area of energy, the capability to carry out comprehensive national energy planning. This may be viewed as acquiring technological capability on the "software" side of energy as contrasted with the "hardware" side ranging from technology research and development to the construction, operation, and maintenance of energy-producing or using equipment. National energy planning is now well recognized as being an essential input into the formulation and execution of economic development programs and policies. In order to carry out national energy planning successfully the following components are necessary: 1. The construction and assemblage of adequate analytical tools to serve as the methodological base for energy planning. 2. The availability of adequate skilled personnel and training programs to impart the requisite skills. 3. The proper institutional setting in which planning can be effective. 4. The necessary political and economic controls to implement the plan. The authors focus on the first two components: the analytical methods useful for energy planning in developing countries and the training needs of energy planning.

2940 Fossil Fuels

REFER ALSO TO CITATION(S) 24499, 24525, 24527, 24527, 24528, 24529, 24546, 24550, 24905, 24910, 24911, 24912, 24913, 24914, 24915, 24916

24919 **(CMI-R—852351-2) Diversifying risk in petroleum exploration.** Flaam, S.D.; Storoey, S. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Dec 1985. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751705.

The report is concerned with the allocation of exploratory effort under the limitation of a fixed budget. The problem is formulated as a non-standard portfolio problem. Risk aversion is included as a probability of ruin constraint. Specifically, the expected revenues are maximized in place of expected utility. The preference for safety is acknowledged by reguiring that the portfolio should furnish a minimal profit with a certain probability p. The figure p accounts for the attitude towards risk, with p=1 meaning full emphasis on secure returns, and p=0 reflecting the preference of an active risk seeker. In addition to the model description a solution procedure and some computational experiences are given.

24920 **(NP—7751729) Coal mining in the West German power industry in the year 1985.** (Statistik der Kohlenwirtschaft e.V., Essen (Germany, F.R.)). Sep 1986. 87p. (In German). NTIS (US Sales Only), MF A01. File Number DE87751729.

A few introductory remarks on the energy market and coal industry, black coal and brown coal mining are followed by a comprehensive collection of tables. The inventories are categorized as follows: black coal mining, brown coal mining, balances of the coal industry, energy consumption, coal deposits, exports and imports, energy balances and global inventories.

24921 **Deregulation: The Administration's position.** Benedict, C. (Deputy Assistant Secretary for Oil, Gas, Shale and Coal Liquids, U.S. Dept. of Energy). pp 55-64 of Natural gas deregulation: Its impact on Illinois and the Midwest. Chicago, IL; University of Chicago Press (1983). (CONF-8310123—).

From 11. annual Illinois energy conference - natural gas deregulation; Chicago, IL, USA (13 Oct 1983).

This paper reviews the issue of natural gas prices and specifically, the Administration's legislative proposal, "The Natural Gas Consumer Regulatory Reform Act of 1983." The objective of the proposal is to ensure that adequate supplies of natural gas are available to consumers at reasonable prices. There is a consensus that this is not happening under existing law. In fact, under current federal controls, gas pricing is inflexible and is required to go in only one direction: up. As a result, gas prices to consumers continue to rise, despite the availability of plentiful supplies.

2950 Hydrogen And Synthetic Fuels

24922 **A summary of DOE hydrogen programs.** Gurevich, M. (Chemical/Hydrogen Energy Systems Program, U.S. Dept. of Energy). pp 191-198 of Proceedings of the international symposium on hydrogen produced from renewable energy. Honolulu, HI; University of Hawaii at Manoa (1984). (CONF-8405122—).

From International symposium on hydrogen produced from renewable energy; Manoa, HI, USA (24 May 1984).

At present, nearly all of the hydrogen produced in the United States is derived from natural gas and petroleum. In future energy systems, which would include hydrogen as an element, hydrogen could be produced by water electrolysis and could be used as a fuel substitute or as an energy carrier similar to electricity. Water would be decomposed into its constituent elements of hydrogen (H/sub 2/) and oxygen (O/sub 2/) using a nondepletable energy source. The hydrogen produced would then be transported through various means, including pipelines, and burned to provide heat energy for the needs of the economy. Since the burning of hydrogen involves combining it with oxygen, the use of hydrogen as a fuel actually comprises a closed system in which hydrogen and oxygen are separated from water requiring the expenditure of energy, and when needed, hydrogen is recombined with oxygen, forming water and in the process releasing useful energy. Hydrogen, like electricity, represents a medium for storing, distributing, and using energy generated from other means. In the future, however, hydrogen could become a major fuel in the event that fossil fuels become too valuable or scarce to burn and hydrogen could be produced economically from renewable or long-term primary sources such as nuclear fission or fusion, solar, or coal.

2960 Electric Power

REFER ALSO TO CITATION(S) 24959, 24960, 25131, 25132, 25509

24923 **(DOE/CE/27460—T23, pp 8.7-8.20) Bonneville's conservation policy analysis model.** Bull, M.; Barton, P. (Bonneville Power Administration, Portland, OR). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

In 1980 the US Congress mandated that the Bonneville Power Administration use conservation as the first priority resource to meet its load obligations. As Bonneville began to address this challenge, it lacked the tools to easily and accurately analyze the system-wide impacts of the many conservation policy options available to it. In 1983 Bonneville began the development of the Conservation Policy Analysis Model (CPAM). The model features full representation of the major components of the electric power system of the Pacific Northwest and treats conservation programs and policies as simulated market responses by using simplified end use modeling. This paper discusses the important attributes of strategic policy analysis tools for conservation in general along with Bonneville's experience with the CPAM effort. Selected policy analysis results and observations and conclusions on future directions for strategic conservation modeling follow the general discussion. 1 figure, 2 tables.

24924 **(DOE/CE/27460—T23, pp 8.21-8.32) Evolving role of end use forecasting models: the case of the Pacific Northwest Power Planning Council.** Corum, K.R. (Northwest Power Planning Council, Portland, OR). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

The Pacific Northwest Power Planning Council has made extensive use of end use models to forecast demand for electricity and to analyze impacts of conservation programs. As the planning process has developed, it has stimulated refinements in the models and data. The paper describes several of these refinements. In some cases they have been able to address these new issues reasonably well (e.g. effects on space heating fuel choice of fuel-specific building efficiency standards). In other cases they have been less successful (e.g. projecting weatherization in response to fuel prices, or projecting changes in wood heat use). While they expected that the models would be a valuable means of forecasting and analyzing conservation questions, they did not foresee how useful they would be for achieving consistency among the components of the Council's integrated planning system. The paper describes a number of ways in which the models have made this achievement possible. The detailed inputs and outputs of the models provide a natural means of checking conservation analysis for consistency with projected demands. In addition, they developed an artificial concept called a frozen efficiency forecast, which is useful in the system-wide simulation of conservation, thermal generation resources and their region's large hydroelectric system.

24925 (DOE/CE/27460—T23, pp 8.33-8.45) **Integrating conservation supply into Austin's load forecast.** Dahlke, D. (Lower Colorado River Authority, Austin, TX). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

In 1982 the City of Austin chose to displace one conventional baseload fired power plant with a 553 MW mix of alternative generation, conservation, load management and innovative rates and regulations. In the four years that have elapsed since Austin adopted this ambitious goal, the programs have evolved and matured to the point where they can be integrated into the electric utilities load forecasting and generation planning process. This paper addresses the theory and practical issues of integrating conservation supply into load forecast and power supply planning based on the experience of Austin Conservation Power Plant programs. 3 references, 5 figures.

24926 (DOE/CE/27460—T23, pp 8.46-8.56) **Figures of merit for evaluating conservation strategies: findings from recent studies with BPA's conservation policy analysis models.** Ford, A.; Geinzer, J. (Univ. of Southern California, Los Angeles). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

This paper summarizes key findings from recent model assisted studies of conservation strategy for the Pacific Northwest. The models, known as CPAM or Conservation Policy Analysis Models, were developed for the Office of Conservation of the Bonneville Power Administration (BPA). A description of BPA's need or CPAM and their recent experiences in using CPAM to assist in conservation studies are described in a separate paper to be presented at the Santa Cruz meetings. This paper presents results from a recently completed sub-regional analyses along with regional results from studies conducted during 1984-1985. The goal of the paper is to show the likely changes in strategy evaluation due to changes in figures of merit used in the evaluation. They also show the likely changes due to explicit consideration of the main sources of uncertainty in electric resource planning. 3 figures.

24927 (DOE/CE/27460—T23, pp 8.57-8.71) **Directions in demand-side management policy.** Ford, C.L.; Thompson, T. (California Public Utilities Commission, San Francisco). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

Demand-side management programs should be treated on an equal footing with supply options in evaluating the desirability of future utility investments to meet customer needs. However, more accurate assessments of the energy and demand reductions resulting from utility demand-side management (DSM) programs are necessary to engender regulatory and utility confidence in some DSM programs. Several recent developments reduce the cost-effectiveness of utility DSM programs, and imply that funding cuts are now appropriate for some California programs. Oil and gas prices have declined such that average gas and electric rates to California ratepayers are now above marginal costs, thus increasing the importance of accurate evaluation of the cost-effectiveness of DSM programs. Some programs, such as those directed toward low income and refugee customers, should be continued for equity reasons, while others which are experimental or apply to new building construction should be continued to avoid loss of opportunity. 2 figures.

24928 (DOE/CE/27460—T23, pp 8.72-8.86) **Using commercial market data for strategic program planning.** Gordon, F.M.; Hickman, C.; Brown, M. (Bonneville Power Administration, Portland, OR). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

This paper demonstrates a method for utilizing market data and projections obtained from end use forecasting models to target conservation programs to the consumers. The method assures that the programs both meet the needs of consumers, and encourage conservation actions which would not have taken place without the programs. Economic and end use analyses are used to estimate the potential long term savings to BPA from 12 building types. Attitudinal studies are then used to show differences in interest in energy conservation among different demographic groups. Demographic studies are used to track the frequency of these factors within each of 12 major commercial building types. The amount of conservation available from each building type is then compared to the degree of interest in conservation among the consumer groups which occupy that building type. This comparison provides an indication of the level of conservation activity which could be expected with and without conservation programs. The major factors influencing consumer interest include the size of the business, the ownership/lease status, the type of corporation or institution, the intensity of load, and the conservation potential per building. 20 references, 7 tables.

24929 (DOE/CE/27460—T23, pp 8.87-8.104) **Residential energy and policy simulation: accuracy of results from the ORNL residential reference house energy demand model.** Hamblin, D.M.; Bibo, L.J. (Bonneville Power Administration, Portland, OR). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

The ORNL Residential Reference House Energy Demand (RRHED) model is a computer-based engineering-economic end-use simulation model which forecasts energy demand and conservation policy impacts based upon a detailed evaluation of how households use energy for particular appliances. The focus of the current study is the revealed accuracy of model predictions in four areas: (1) aggregate electricity sales over a five-year historical period; (2) new structure penetration projections for space and water heat; (3) aggregate space heat energy use per new buildings; and (4) costs of conserved energy for shell improvements. The geographic area for analysis is the Pacific Northwest area of Bonneville Power Administration service. The RRHED model produces weather adjusted forecasts for historical years. These predictions for Public and Private Rate Pools are compared to actual sales data. The adequacy of the nested logit qualitative choice simulation mechanism is analyzed by comparing 1983 simulations with 1983 Pacific Northwest Residential Energy Survey results. New structure space heat electricity consumption estimates are validated against analysis data available from diverse sources. RRHED predictions for the cost of programmatic initiative conserved energy are evaluated for consistency and accuracy by comparison of output shadow price results with external computations. 14 references, 6 tables.

24930 (DOE/CE/27460—T23, pp 8.105-8.117) **Program planning to please all of the people all of the time.** Herman, P.; Clinton, J. (Barakat, Howard & Chamberlin, Inc., Berkeley, CA). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

For a building energy efficiency program to be successful it doesn't need to please all, but it must be considered beneficial or cost-effective by the decision makers involved. This paper presents and demonstrates a simple analytical tool to aid in demand-side program planning, design, and evaluation. This tool requires very little time, effort, and data to quickly calculate and recalculate the cost-effectiveness of a potential or existing program from the following points of view: the program participant, the non-participating ratepayers, all ratepayers, utility resource planning, and society. A tool like this is essential for program planning for the following reasons: (1) sensitivity analysis is easily performed which allows valuable resources to be focused on estimating the program design elements that most strongly affect cost-effectiveness; (2) any decision is easier with complete information. This tool brings all of the elements of cost-effectiveness together creating a simplifying context for program decisions; (3) knowledge of the cost-effectiveness of the program and the factors affecting it is invaluable in supporting and justifying a program; (4) quick calculation allows easy monitoring of regulatory cost-effectiveness criteria, and full support documentation is readily available; and (5) use of this type of tool enables program designers to approach pleasing all of the people all of the time. 5 tables.

24931 (DOE/CE/27460—T23, pp 8.134-8.146) **Integration of conservation program savings in long run energy demand forecasts.** Jaske, M.R.; Schultz, D.K.; Gorin, T.A.; Baxter, L.W. (California Energy Commission, Sacramento, CA). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

This paper shares the authors' perspectives on several issues arising from the development and use of end use forecasting models to quantify conservation program savings. Experiences from ten years effort at forecasting are offered. What lessons have been learned? What difficulties encountered in using forecasting models to quantify conservation programs have been resolved? What ones still exist? This paper examines some of these questions for the residential and commercial building sector energy models and the peak load model used to produce long run forecasts. How should conservation and load management program savings be included within a long run resource planning process? Criteria for treating savings of individual programs, integrating program quantification and forecasting models, and attributing savings among programs are discussed from the CEC perspective. The effect of revisions to program savings estimates on credibility is also considered. 11 references, 4 tables.

24932 (DOE/CE/27460—T23, pp 8.147-8.160) **Valuation of demand side utility programs.** Kahn, E.; Eto, J.; Koomey, J.; McMahon, J.; Chan, P.; Levine, M. (Lawrence Berkeley Lab., CA). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

This paper examines large scale demand side programs whose impacts require a change in utility supply plans. The benefits of the programs are defined in terms of the costs or value of power plants expected in service that are deferred by the programs in question. Case studies are developed for standards programs that increase the efficiency of residential appliances. The utilities studied are the Nevada Power Company and the Texas Utilities Electric Company. The annual energy and hourly load impacts of these programs are calculated using the LBL Residential Energy and Hourly Demand models calibrated to data for the specific utilities. The Nevada Power case focuses on determining the optimal deferral period by using production simulation modelling techniques. In the Texas Utilities case they use cost data based on purchase terms offered to cogenerators as the valuation method. In this case the procedures for allocating capacity value are the focus of attention. Two different rules are examined. The principal result of these studies is the divergence of social value from value to the utility. Programs which are cost-effective to the utility usually are net losers to society. This is due to the high cost of air-conditioning efficiency improvements and the low cost of power for these utilities. Expected reductions in the cost premium for efficient appliances still do not produce uniformly positive benefits to society. 13 references, 5 figures, 6 tables.

24933 (DOE/CE/27460—T23, pp 8.175-8.184) **Comprehensive assessment of conservation opportunity for utility long-range planning: CONPRO - a computer simulation.** Norland, D.L. (Alliance to Save Energy, Washington, DC). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

This paper presents preliminary results of a case-study with General Public Utilities to estimate the opportunity for conservation in its Pennsylvania Electric Company subsidiary. By conservation opportunity they mean the maximum amount of electricity or capacity savings available from investment in electricity conservation and load management applications that are economic from the perspective of individual consumers or society. Over seventy-five electricity conservation alternatives (ECAs) for the residential, commercial and industrial classes were identified and evaluated across twenty-one end-uses. For the society viewpoint, the ECAs were evaluated at a single society discount rate and the utility's marginal costs. For the consumer point of view, ECAs were evaluated using customer class discount rate distributions and calculated savings in electric bills. Total conservation opportunity was estimated each year for 1985 to 2004 for each perspective and compared to the utility's energy and load forecasts. All calculations were performed using a micro-computer simulation program developed for the project called CONPRO. 2 figures, 2 tables.

24934 (DOE/CE/27460—T23, pp 8.185-8.194) **Role of mainframe computer models in least-cost utility planning.** Pignone, C.; Eto, J.; Kahn, E. (Lawrence Berkeley Lab., CA). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154. Contract AC03-76SF00098.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

Electric utility companies are increasingly using main frame computer models as their central planning tools. Adoption of modelling represents a response to the complexities that have complicated planning over the last few years. At the same time, the concept of least-cost utility planning is gaining acceptance among regulators and, more slowly, utilities as the guiding principle of planning. The interaction between these two significant changes in industry thinking and methods is described, and two of the leading planning models are evaluated for usefulness as tools in the least-cost planning process. It is argued that for better or worse computer modelling is de facto the industry's chosen road to least-cost planning, and, indeed, no alternative is apparent. Further, regulators and policymakers must adopt comparable modelling capability if useful exchange is to continue in the industry.

24935 (DOE/CE/27460—T23, pp 8.203-8.216) **Effect of energy conservation measures on residential electricity demand and load shape.** Ruderman, H.; Levine, M.D.; Chan, P. (Lawrence Berkeley Lab., CA). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154. Contract AC03-76SF00098.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

The authors have developed a method for calculating changes in annual electricity consumption and hourly loads in the residential sector resulting from the implementation of one or more energy conservation measures in a utility service area. They used the methodology to evaluate different measures by comparing their impacts in three service areas with differing load characteristics. The measures included improvements to the thermal integrity of the building, increased appliance efficiencies, as well as combinations of these measures. Three service areas were selected that differed widely in their climatic conditions, appliance saturations, and other household characteristics. The conservation measures were evaluated by comparing their impacts on electricity sales and on peak summer and winter loads. The measures were ranked on the basis of a figure-of-merit related to their ability to reduce peak loads relative to electricity consumption. These results can be used to determine the financial impact of the measures on electric utilities. 5 references, 4 tables.

24936 **(EPRI-EM—4961) Planning and managing market research: Electric utility market research monograph series: Monograph 1.** Whitelaw, R.W. (Electric Power Research Inst., Palo Alto, CA (USA)). 1987. 69p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920336.

The market research techniques available now to the electric utility industry have evolved over the last thirty years into a set of sophisticated tools that permit complex behavioral analyses that earlier had been impossible. The marketing questions facing the electric utility industry now are commensurately more complex than ever before. This document was undertaken to present the tools and techniques needed to start or improve the usefulness of market research activities within electric utilities. It describes proven planning and management techniques as well as decision criteria for structuring effective market research functions for each utility's particular needs. The monograph establishes the parameters of sound utility market research given trade-offs between highly centralized or decentralized organizations, research focus, involvement in decision making, and personnel and management skills necessary to maximize the effectiveness of the structure chosen.

24937 **(EPRI-EM—4962) Attitude and image measurement: Electric utility market research monograph series: Monograph 2.** Morrison, A.J.; Lutz, R.J. (Electric Power Research Inst., Palo Alto, CA (USA)). 1987. 92p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920337.

Goal of this monograph is to provide a straightforward, illustrated approach to conceptualizing and executing various types of attitude and image research within a utility company environment. To this end, the monograph has summarized and synthesized a variety of attitude theory and research techniques which have been elaborated in great detail in other publications. We have included a list of readings as an Appendix.

24938 **(EPRI-EM—5114) Forecast Master Program case studies: Final report.** Engle, R.; Granger, C.; Ramanathan, R. (ed.). (Quantitative Economic Research, Inc., San Diego, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Apr 1987. 234p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920354.

This report presents a number of case studies using the computer software package FORECAST MASTER (FM). The series studied and forecast are, aggregate monthly California Electricity Sales, system energy demand data from Ontario Hydro, peak demand data for the residential and commercial customers of Georgia Power Company, Massachusetts Electric commercial sales, Narragansett Electric commercial sales, average and peak demand using Georgia Power Company data. A variety of methods have been studied by each of the contributing authors; trend line fitting, exponential smoothing, Box-Jenkins univariate forecasting, vector autoregression, state space modeling, dynamic econometric models including time-varying parameters and general order serial correlation corrections. Thus both the data sets and the modeling/forecasting methodologies are varied. A number of conclusions emerge from these case studies: FM provides a powerful set of tools to aid a utility forecaster, a great deal of caution should be exercised in pre-processing the data; it can have unintended side effects, diagnostic tests are very useful in econometric models, the Akaike Information Criterion is a useful measure for selecting the best state space model, and state space and econometric approaches both need equal amounts of care in model analysis and presentation.

24939 **(EPRI-P—5087) Project risk analysis: A case study of plant life extension: Final report.** Farber, M. (Temple, Barker and Sloane, Inc., Lexington, MA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 42p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920327.

Economic and financial analysis of power plant improvement projects is likely to become more important over time. Particularly as utilities consider plant life extension, project choices will become more numerous: modification vs total replacement; replacement-in-kind vs upgrade; and immediate action vs delayed implementation. As life extension competes with other options for investment dollars, project risk analysis can help utilities improve investment decisions. This report applies project risk analysis techniques to life extension. For a sample project, a series of three increasingly sophisticated analyses is presented. The examples demonstrate the value of risk analysis and illustrate the techniques. The analyses can be done very efficiently - all of the risk analyses were performed with a microcomputer spreadsheet.

24940 **(NP—7751715) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.3: Energy distribution. Chapter A.4.3.1. Electricity.** Tornier. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). 1983. 63p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751715.

In the framework of a comparative analysis on the use of the alternative energy sources gas, electricity and district heat, more specific data are provided as regards the sector of electricity. The following are dealt with in detail: delimitation (electric power generation, electricity conduction, power distribution; household sector, power distribution via low-voltage grid) and technical systems such as medium- and low-voltage grids as well as system load portions, heating systems and system loads (direct heating, storage heating, heat pump). Furthermore the cost in the area of distribution (target, model set-up and marginal conditions) is considered as well as the cost of individual items of working stock (low- and medium-voltage cable grids) and the construction and cost of grids for 'normal power supply'. Other topics dealt with were: storage heating systems and the share of energy required by heat pumps, grids for all-electricity supply (storage heating systems, heat pumps). Finally the specific investment cost in the distribution sector and specific cost of distribution are summarized. The report terminates with the assumption that the combination of storage and heat pump heating systems could entail more favourable distribution costs. (HWJ).

24941 **(PB—87-142428/XAB) Annual electric generator report, 1985 (Form EIA-860). Data file.** Bess, E. (USDOE Energy Information Administration, Washington, DC). 1985. vp. NTISCP T02.

Supersedes PB—86-172376; Source tape is in the EBCDIC character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. Call NTIS Computer Products if you have questions.

The product contains data on the status of electric generating plants and associated equipment in operation and those scheduled to be in operation within 10 years of the current reporting period, in the United States and Puerto Rico. The data are contained in three files: (1) F860.GEN.UNIT - Generator level data; (2) F860.PLANT - Plant level data; (3) F860.UTILITY - Utility level data.

24942 **(TVA/OP/EUDR—87/1) Statistics: Distributors of TVA power, Fiscal years 1982-1986.** (Tennessee Valley Authority, Chattanooga (USA). Div. of Energy Use and Distributor Relations). 1987. 190p. NTIS MF A01. File Number DE87900614.

Degree-days for the winter of 1985-86 were 12% less than normal and 7% less than the previous winter. Residential average use decreased slightly from 13,606 kWh to 13,476 kWh (the all-time high of 16,251 kWh occurred in fiscal year 1978). Despite the warmer weather, customer load growth caused total sales by the distributors to increase by 2% during fiscal year 1986. Including the effects of the elimination of Power Credits and implementation of the October 2, 1985 Adjustment Addendum, revenue per kWh and power cost per kWh increased by 5%. Operation and maintenance expenses per consumer for all distributors increased 1% in 1986. Operation and maintenance expenses per consumer for the four largest municipalities decreased 1%, while expenses per consumer for the smaller municipalities increased by 3% and for the cooperatives by 2%. On a per-kWh-basis, operating expenses for all distributors increased 1%. The four largest municipalities showed no increase, the smaller municipalities a 3% increase, and the cooperatives a 2% increase.

24943 **(TVA/PE/PE/INFO—86/18-Vol.2) 1986 Power Program summary: Volume 2, Financial and statistical report for municipal and cooperative distributors of TVA power, Fiscal year ending June 30, 1986.** (Tennessee Valley Authority, Knoxville (USA)). 30 Jun 1986. 59p. NTIS, PC A04. File Number DE87900620.

The Tennessee Valley Authority provides power to 110 municipal and 50 cooperative electric systems for distribution to 3.1 million customers. The locally owned distributors serve an 80,000-square-mile area in parts of seven states with a population of an estimated 7 million. This report reflects the operations of those distributors during their fiscal year ending June 30, 1986. TVA gathered the data from annual reports and other material prepared by each of the 160 distributors.

24944 **Bonneville Power Administration conservation/load/resource modeling process.** Tonn, B. (Oak Ridge National Lab., TN). *Energy Systems and Policy;* **10**: No. 4, 277-309(1987). Contract AC05-84OR21400.

Utilities in the US are attempting to improve their analytic capabilities, especially by integrating supply side and demand side planning. This article documents the Bonneville Power Administration's complex conservation/load/resource modeling process as it existed between September 1984 and March 1985. Descriptions of conservation forecasting, power forecasting, and resource acquisition models are provided, and flows of conservation data between models are traced. An evaluation of the modeling process with respect to conservation concludes the article. 21 references, 8 figures.

24945 **Projecting electricity consumption with an econometric model.** Sutherland, R.J. (Los Alamos National Lab., NM). *Energy Systems and Policy;* **10**: No. 4, 325-343(1987).

Using an econometric model estimated with state data for the period 1961-1982, long-term projections of the growth rate in electricity consumption are presented. A projection of 3.25% per year is produced by an aggregate model. Using a similar model estimated on a regional basis, an aggregate projection of 4.19% is obtained. The main variable contributing to these projections are economic expansion, broadly defined to include income and the number of customers. Although the price of electricity is a statistically significant variable, this price is projected to be approximately stable in real terms, and hence not to contribute to electricity demand. 10 references, 1 figure, 5 tables.

24946 **The role of auditor salesmanship in residential conservation incentive programs: A case study.** Brown, M.A.; Berry, L.G.; White, D.L.; Zeidler, P. (Oak Ridge National Lab., Oak Ridge, TN). pp 395-406 of Productivity through energy innovation. Smith, C.B.; Davis, T.; Keneipp, M. Elmsford, NY; Pergamon Books Inc. (1986). (CONF-8604109—). Contract AC05-84OR21400.

From Pacific Gas and Electric (PG and E) energy expo; Oakland, CA, USA (29 Apr 1986).

This paper examines the role of auditor salesmanship in four residential conservation incentive programs offered by Florida Power and Light (FPL). Regression analysis was used to examine variations in levels of program participation attributable to auditor differences, after controlling for variations in the types of households served by each auditor. Auditor characteristics are found to explain as much as 14% of the total variation in the performance measures, when entered after statistically significant household characteristics. In particular, auditor attributes such as years of education, previous sales experience, and extroversion are found to influence sales effectiveness.

24947 **Planning for an uncertain future: An overview of BPA's 1986 Resource Strategy.** Scanlon, T.J. (Bonneville Power Administration, Portland, OR). pp 295-304 of Productivity through energy innovation. Smith, C.B.; Davis, T.; Keneipp, M. Elmsford, NY; Pergamon Books Inc. (1986). (CONF-8604109—).

From Pacific Gas and Electric (PG and E) energy expo; Oakland, CA, USA (29 Apr 1986).

This paper describes the Bonneville Power Administration's (BPA's) planning process for developing a comprehensive resource strategy to meet future electricity requirements in the Pacific Northwest. Focus is on the analytical framework used to develop and test the conservation component of BPA's 1986 Resource Strategy; descriptions of the conservation strategies under consideration; and the selection criteria for determining a preferred strategy.

24948 **Marketing a direct load control program.** Reed, J.H. (Energy Div., Oak Ridge National Lab., Oak Ridge, TN 37831). pp 366-376 of Productivity through energy innovation. Smith, C.B.; Davis, T.; Keneipp, M. Elmsford, NY; Pergamon Books Inc. (1986). (CONF-8604109—). Contract AC05-84OR21400.

From Pacific Gas and Electric (PG and E) energy expo; Oakland, CA, USA (29 Apr 1986).

This paper describes the customer marketing plan for the Athens Automation and Control Experiment being conducted in Athens, Tennessee. A cluster analysis of monthly billing data was used to identify customers who are likely to have electric central space-conditioning appliances and electric water heaters. When compared with other customers, those selected tend to have higher incomes, have more rooms in their dwelling units, and be 40-60 years old. This paper describes how the marketing strategy was developed and how it is being implemented. Marketing is keyed to personal contact. Direct monetary incentives are not being used in the Athen project. Early results from the use of the strategy suggest that it is very successful.

24949 **Energy conservation strategies and the use of market research in times of system surplus.** Johnson, D.R.; Fang, J.M.; Ivey, D.L. (Pacific Northwest Lab., Richland, WA). pp 517-524 of Productivity through energy innovation. Smith, C.B.; Davis, T.; Keneipp, M. Elmsford, NY; Pergamon Books Inc. (1986). (CONF-8604109—).

From Pacific Gas and Electric (PG and E) energy expo; Oakland, CA, USA (29 Apr 1986).

Energy conservation programs have become recognized as effective tools for utilities interested in deferring the need for new generating units. However, many utilities currently find themselves in circumstances in which generating capacity exceeds demand. This paper explores appropriate conservation strategies under these circumstances. The general approach is to build the capability to quickly acquire conservation resources in the future when they are needed, using market segmentation and market research. A strategy for some market segments involves maintaining and reinforcing the likelihood of future investment in energy conservation. A separate strategy involves cultivating other market segments to increase the likelihood of future investment.

2980 Consumption And Utilization

REFER ALSO TO CITATION(S) 25124

24950 (CONF-8309248—, pp 265-277) **Consequences of different scenarios for the future use of various energy resources.** Leydon, K. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

The purpose of this paper is to provide a range of estimates of fuel consumption over the next two decades. These have been prepared by the Commission services as part of a major exercise in scenario analysis for the ten Member States which has recently been completed. While the results are, therefore, preliminary, this important step in evaluating energy scenarios on an integrated basis for the Member States and provides major opportunities for future energy analysis.

24951 (ORNL/TM—10325) Sensitivity analysis of the commercial energy use module of the Commercial and Residential Energy Use and Emissions Simulation System (CRESS). Trowbridge, L.D. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 56p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007797.

A sensitivity analysis of CSEM2, the commercial energy use component of Argonne National Laboratory's Commercial and Residential Energy Use and Emissions Simulation (CRESS) has been carried out using an automated sensitivity analysis tool developed at Oak Ridge National Laboratory. CSEM2 projects US commercial sector energy use from a number of historical and projected economic and demographic parameters. The energy use projections from CSEM2 are used in later modules of CRESS to make projections of emissions for five fossil energy-related atmospheric pollutants. Sensitivities of commercial energy use projections to the various driver and control parameters are presented in this report.

2990 Unconventional Sources And Power Generation

REFER ALSO TO CITATION(S) 24679, 24683, 24684, 24685, 24686, 24687, 24696, 24705, 24707, 24718, 24719, 24720, 24757, 25772

24952 Macro modeling of energy from agriculture. Turhollow, A.F. (Energy Div., Oak Ridge National Lab., Oak Ridge, TN 37831). pp 1375-1380 of Proceedings of the 16th annual Pittsburgh conference on modeling and simulation. Vol. 16. Part 1. Hanham, R.; Vogt, W.G.; Mickie, M.H. Pittsburgh, PA; University of Pittsburgh (1985). (CONF-8504134—). Contract AC05-84OR21400.

From 16. Instrument Society of America modeling and simulation conference; Pittsburgh, PA, USA (25 Apr 1985).

Macro-level modeling of energy from agriculture has focused primarily on the production of ethanol from corn, with a few studies on the use of crop residues, oilseeds, and lignocellulosic crops. Both econometric simulation and mathematical programming models have been used. Some methods of improving these models are discussed. Research is now focusing on the use of lignocellulosic crops--agricultural and woody--and oilseeds dedicated to energy production.

24953 A spatial model of a biomass energy plantation. Jones, D.W.; Krummel, J.R. (Energy Div., Oak Ridge National Lab., Oak Ridge, TN 37831). pp 193-198 of Proceedings of the 16th annual Pittsburgh conference on modeling and simulation. Vol. 16. Part 1. Hanham, R.; Vogt, W.G.; Mickie, M.H. Pittsburgh, PA; University of Pittsburgh (1985). (CONF-8504134—).

From 16. Instrument Society of America modeling and simulation conference; Pittsburgh, PA, USA (25 Apr 1985).

The development of biomass energy resources is an issue of major concern in many Third World countries. Many of them derive anywhere from 45% to 90% of their energy from biomass sources. In rural areas fuelwood has been considered a free good, at the cost only of labor time in collection. With continuing population growth, nearby forests are being exhausted in numerous countries, and labor costs of reaching remaining forested areas are rising. Urbanization puts similar strains on fuelwood distribution systems. While biomass energy sources are probably not long term answers to Third World energy problems, energy supplies from biomass can continue to provide significant near-term needs. To limit both environmental problems (i.e. deforestation) and labor costs of harvesting remaining natural forest stands, future biomass energy developments will require the introduction of systematic, rotational forestry on energy - probably tree - plantations, more efficient conversion of raw feedstocks (the trees) to charcoal or other fuels more transportable than raw wood, and more efficient combustion technology for consumers.

30 DIRECT ENERGY CONVERSION

REFER ALSO TO CITATION(S) 24717

3001 Mhd Generators

24954 (DOE/ET/15601—21) Diagnostic development and support of MHD [magnetohydrodynamics] test facilities: Technical progress report for the period April, May, June 1985. Shepard, W.S. (Mississippi State Univ., Mississippi State (USA). MHD Energy Center). Jul 1985. Contract AC02-80ET15601. 46p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006792.

Mississippi State University is developing diagnostic instruments for MHD power train data acquisition and for support of MHD component development test facilities. Microprocessor-controlled optical instruments, initially developed for HRSR support, are being refined, and new systems to measure temperatures and gas-seed-slag stream characteristics are being developed. To further data acquisition and analysis capabilities, the diagnostic systems are being interfaced with MHD Energy Center computers. Additionally, technical support of the diagnostic needs of the national MHD research effort is being provided. 8 figs.

24955 (N—87-11837) Space-based laser-driven MHD generator: feasibility study. Final report. Choi, S.H. (Information and Control Systems, Inc., Hampton, VA (USA)). Oct 1986. 52p. (NASA-CR—178184; NAS—1.26:178184; REPT—681104). NTIS, PC A04/MF A01.

The feasibility of a laser-driven MHD generator, as a candidate receiver for a space-based laser power transmission system, was investigated. On the basis of reasonable parameters obtained in the literature, a model of the laser-driven MHD generator was developed with the assumptions of a steady, turbulent, two-dimensional flow. These assumptions were based on the continuous and steady generation of plasmas by the exposure of the continuous wave laser beam thus inducing a steady back pressure that enables the medium to flow steadily. The model considered here took the turbulent nature of plasmas into account in the two-dimensional geometry of the generator. For these conditions with the plasma parameters defining the thermal conductivity, viscosity, electrical conductivity for the plasma flow, a generator efficiency of 53.3% was calculated. If turbulent effects and nonequilibrium ionization are taken into account, the efficiency is 43.2%. The study shows that the laser-driven MHD system has potential as a laser power receiver for space applications because of its high energy conversion efficiency, high energy density and relatively simple mechanism as compared to other energy conversion cycles.

24956 (SERI/CP—252-2714, pp 187-198) **Liquid metal MHD conversion for solar thermal systems.** Jackson, W. (HMJ Corp., Chevy Chase, MD). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

The science of magnetohydrodynamics (MHD) deals with the interaction of electrically conducting fluids with electromagnetic fields. The fluids may be liquid metals, electrolytes, two-phase flows comprising a gas or vapor with a continuously connected conducting liquid phase, a slightly ionized gas (or plasma) or a fully ionized plasma. The application of MDH to electric power generation involves the driving of one of these conducting fluids through a magnetic field with appropriate electrode or inductive coupling circuits. The motionally induced electromotive force causes current to flow in an electric circuit and so deliver power to a load appropriately matched through a power conditioning system. MHD conversion can provide the basis for a heat engine converting the enthalpy of the working fluid directly to electrical form provided only that the working fluid is a sufficiently good electrical conductor to ensure that the generated power substantially exceeds the losses per unit volume. This concept is discussed.

3002 Ehd Generators

24957 (SERI/CP—252-2714, pp 181-185) **Electrohydrodynamic generator for use with dissimilar fluids.** Gawain, T.H.; Biblarz, O. (Naval Postgraduate School, Monterey, CA). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

An electrohydrodynamic generator (EHD) design employing dissimilar fluids for the primary and secondary fluids is proposed. The electrical working section is disposed after the condenser/separator and before the ejector pump. The primary fluid vapor does not pass through the electrical working section, thereby avoiding many difficulties of the previous designs.

3003 Thermoelectric Generators

24958 **Thermoelectric generator and method for the fabrication thereof.** Benson, D.K.; Tracy, C.E. (to Dept. of Energy, Washington, DC). US Patent 4,650,919. 17 Mar 1987. Filed date 1 Aug 1984. vp.

A method is described for fabricating a thermoelectric generator comprising the steps of: forming substrates with a thermally conductive and electrically conductive metallic plate on at least one surface of each substrate; forming at least one thin thermoelectric semiconductor element on the plates of some of the substrates to form a first thermal and electrical junction at the interface of the substrate plate and the thermoelectric semiconductor element on the substrates; using others of the substrates as superstrates and connecting the plate of each superstrate to the side of the thermoelectric semiconductor element opposite the substrate to form a second thermal and electrical junction at the interface of each superstrate plate and the respective thermoelectric semiconductor. Modules are formed with each module comprising the thin thermoelectric semiconductor element located between a substrate and a superstrate; and using modules to form a thermoelectric generator by arranging the modules so that one junction of each module is positioned adjacent and in thermal contact with a hot fluid carrying conduit and the other junction of each module is positioned adjacent and in thermal contact with a cold fluid carrying conduit.

3005 Fuel Cells

REFER ALSO TO CITATION(S) 25198

24959 **(AD-A—176066/9/XAB) Demonstrate cyclic reforming of logistic fuel for fuel-cell power plants. Final technical report, 26 August 1985-28 February 1986.** Sederquist, R.A.; Sandelli, G.J.; Lane, J.W. (International Fuel Cells Corp., South Windsor, CT (USA)). 16 May 1986. 111p. (FCR—7888A). NTIS, PC A06/MF A01.

A program was conducted, sponsored by the U.S. Army, to demonstrate cyclic reforming of military logistic fuel. This report describes the technical effort and results of the design, fabrication and test of a nominal 20-kW fuel-cell cyclic-reformer fuel-processing system. The objective of the program was to demonstrate the ability to produce a hydrogen-rich gaseous product stream suitable for use as a feed stream to a phosphoric acid fuel-cell power plant utilizing military logistic fuel. Included in this final report is the basis for the selection of the cyclic-reforming process, a description of the test-train design, a discussion of the test and results, and the analysis of the data obtained.

24960 **(PB—87-147476/XAB) Support services to gas-industry onsite fuel-cell users group. Annual report, July 1985-June 1986.** Parker, A.J. (Mueller Associates, Inc., Baltimore, MD (USA)). 30 Jun 1986. 22p. NTIS, PC A02/MF A01.

The 40-kW phosphoric acid onsite fuel cell was developed to a point of technical excellence. Its operation has been successfully studied in a 4-year, international field-test program. A 200-kW fuel-cell power plant is under development, and market assessment was done. To support the Gas Industry Onsite Fuel Cell Users Group to convey development status and technical and applications information to an internal and an external audience, MAI provided services in three task areas: (1) Coordination of production of the Powercel News newsletter; (2) Attendance at, reporting on, and coordinating arrangements for fuel-cell-related workshops and meetings; (3) Performance of special studies. Each task area is reported.

24961 **Fuel processor for fuel cell power system.** Vanderborgh, N.E.; Springer, T.E.; Huff, J.R. (to Dept. of Energy, Washington, DC). US Patent 4,650,727. 17 Mar 1987. Filed date 28 Jan 1986. vp.

A catalytic organic fuel processing apparatus is described comprising: A. a housing; B. a catalyst containing chamber within the housing; C. means to recirculate gases at varying velocities through the catalyst chamber and within the housing; D. means to inject varying amounts of organic fuel into the recirculating gases; E. a combustion chamber containing a combustion catalyst on the inside and an oxidation catalyst on the outside, the combustion chamber in indirect heat exchange relationship with the means to inject organic fuel and in both indirect and direct heat exchange relationship with the recirculating gases; F. means to selectively inject air into the recirculating gases upstream of the combustion chamber; G. means to inject varying amounts of fuel and air into the combustion chamber; and H. means to selectively draw off recirculating gases without at the same time drawing off substantial quantities of newly introduced organic fuel vapor.

24962 **Molten carbonate fuel cell.** Kaun, T.D.; Smith, J.L. (to Dept. of Energy). US Patent Application 6-833,217. 8 Jul 1986. 21p. Contract W-31109-ENG-38. DE87007195 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007195.

A molten electrolyte fuel cell is disclosed with an array of stacked cells and cell enclosures isolating each cell except for access to gas manifolds for the supply of fuel or oxidant gas or the removal of waste gas. The cell enclosures collectively provide an enclosure for the array and effectively avoid the problems of electrolyte migration and the previous need for compression of stack components. The fuel cell further includes an inner housing about and in cooperation with the array enclosure to provide a manifold system with isolated chambers for the supply and removal of gases. An external insulated housing about the inner housing provides thermal isolation to the cell components.

24963 **Electrolyte matrix in a molten carbonate fuel cell stack.** Reiser, C.A.; Maricle, D.L. (to Dept. of Energy). US Patent Application 6-867,123. 27 May 1986. 17p. Contract AC21-79ET15440. DE87007255 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007255.

A fuel cell stack is disclosed with modified electrolyte matrices for limiting the electrolytic pumping and electrolyte migration along the stack external surfaces. Each of the matrices includes marginal portions at the stack face of substantially greater pore size than that of the central body of the matrix. Consequently, these marginal portions have insufficient electrolyte fill to support pumping or wicking of electrolyte from the center of the stack to the face surfaces in contact with the vertical seals. Various configurations of the marginal portions include a complete perimeter, opposite edge portions corresponding to the air plenums and tab size portions corresponding to the manifold seal locations. These margins will substantially limit the migration of electrolyte to and along the porous manifold seals during operation of the electrochemical cell stack.

24964 **Method of preparing a dimensionally stable electrode for use in a molten carbonate fuel cell.** Swarr, T.E.; Wnuck, W.G. (to Dept. of Energy). US Patent Application 6-823,718. 29 Jan 1986. 19p. Contract AC21-79ET15440. DE87007294 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007294.

A method is disclosed for preparing a dimensionally stable electrode structure, particularly nickel-chromium anodes, for use in a molten carbonate fuel cell stack. A low-chromium to nickel alloy is provided and oxidized in a mildly oxidizing gas of sufficient oxidation potential to oxidize chromium in the alloy structure. Typically, a steam/H_2 gas mixture in a ratio of about 100/1 and at a temperature below 800°C is used as the oxidizing medium. This method permits the use of less than 5 wt % chromium in nickel alloy electrodes while obtaining good resistance to creep in the electrodes of a fuel cell stack.

24965 **Fuel processor for fuel cell power system.** Vanderborgh, N.E.; Springer, T.E.; Huff, J.R. (to Dept. of Energy). US Patent Application 6-823,544. 28 Jan 1986. 25p. Contract W-7405-ENG-36. DE87007292 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007292.

A catalytic organic fuel processing apparatus, which can be used in a fuel cell power system, contains within a housing a catalyst chamber, a variable speed fan, and a combustion chamber. Vaporized organic fuel is circulated by the fan past the combustion chamber with which it is in indirect heat exchange relationship. The heated vaporized organic fuel enters a catalyst bed where it is converted into a desired product such as hydrogen needed to power the fuel cell. During periods of high demand, air is injected upstream of the combustion chamber and organic fuel injection means to burn with some of the organic fuel on the outside of the combustion chamber, and thus be in direct heat exchange relation with the organic fuel going into the catalyst bed.

24966 **Device for equalizing molten electrolyte content in a fuel cell stack.** Smith, J.L. (to Dept. of Energy). US Patent Application 6-812,575. 23 Dec 1985. 15p. Contract W-31-109-ENG-38. DE87007286 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007286.

A device for equalizing the molten electrolyte content throughout the height of a fuel cell stack is disclosed. The device includes a passageway for electrolyte return with electrolyte wettable wicking material in the opposite end portions of the passageway. One end portion is disposed near the upper, negative end of the stack where electrolyte flooding occurs. The second end portion is placed near the lower, positive end of the stack where electrolyte is depleted. Heating means are provided at the upper portion of the passageway to increase electrolyte vapor pressure in the upper wicking material. The vapor is condensed in the lower passageway portion and conducted as molten electrolyte in the lower wick to the positive end face of the stack. An inlet is provided to inject a modifying gas into the passageway and thereby control the rate of electrolyte return.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

3201 Buildings

REFER ALSO TO CITATION(S) 24551, 24553, 24741, 24741, 24901, 24902, 24903, 24935, 24946, 25158, 25216, 25217, 25265, 25430, 25506, 25831, 25832

24967 **(CMI-R—842240-3) Domestic energy conservation in the United Kingdom.** Bird, P.J.W.N. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Feb 1985. 28p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751704.

The progress of domestic energy conservation in the United Kingdom is surveyed. The domestic energy market represents approximately 27% of energy delivered in the economy as a whole. More than 5/6 of the consumption in the domestic sector is for space and water heating. The particular topic of interest is the effect of energy conservation measures undertaken by the householder. Special emphasis is given to loft and cavity wall insulation. Government policies are reviewed and criticized. Estimates are produced of the impact to date, and the future potential impact of conservation on domestic energy demand. 1 drawing, 11 tables.

24968 **(CONF-870584—1) The fiber optic refrigeration cycle monitor.** Klatt, L.N.; Bostick, D.T.; Perez-Blanco, H. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 6p. NTIS, PC A02. File Number DE87006632.

From Technical symposium southeast on optics, electrooptics and sensors; Orlando, FL, USA (17 May 1987).

The measurement of absorbent concentration is a key control parameter in operating and assessing the performance of absorption heat pump systems. Because most refrigerant absorbent fluids are binary mixtures, the measurement of refractive index has been used routinely to directly determine the concentration of absorbent fluid components. Until recently, this measurement has been limited to the analysis of samples withdrawn from the absorption machine after system shut-down. The Fiber Optic Refrigeration Cycle Monitor (FORCM) is the first device capable of making multiple and in-situ, real-time measurements of refractive index at user-definable points within operating absorption machines. The refractive index of the solution is determined by measuring light loss from an unclad segment of an optical fiber that is immersed in the absorption fluid. Changes in fluid refractive index alter the angle at which the light rays are totally internally reflected at the core-fluid interface, thereby altering the light transmission efficiency of the fiber. The unclad portion of the fiber is placed at a point within the absorption vessel for which the fluid composition measurement is desired. Any number of modified optical fibers can be installed within a system. A thermocouple junction adjacent to each fiber measures the local fluid temperature. The combination of local concentration and temperature measurements allows in-line monitoring and control of the system, as well as provides a detailed study of heat and mass transfer processes occurring within these machines. The operating characteristics of the FORCM are described in this paper.

24969 **(DOE/CE/27460—T2, pp 62-76) Tracking consumer attitudes on energy conservation in the Pacific Northwest.** Fang, J.M. (Pacific Northwest Lab., Richland, WA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005153. Contract AC06-76RL01830.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 7, Proceedings from the panel on social and health factors.

Measurement of consumer attitudes and characteristics allows for the segmentation of the market in a variety of ways to aid in the development and implementation of effective energy conservation programs in the residential sector. Pacific Northwest Laboratory has been conducting marketing analyses for energy conservation activities in the Pacific Northwest for Bonneville Power Administration since 1983. Work completed to date includes a region-wide telephone survey of consumer attitudes conducted in 1983 and several studies characterizing the analyzing specific market segments. In late 1985, a second region-wide consumer attitudes survey was conducted and analyses of the survey data are being performed. The purpose of this paper is to present the results of a tracking analysis of the changes in consumer attitudes and behaviors between 1983 and 1985. Consumer understanding and perceptions of energy conservation and other issues are explained first. Results concerning past and potential energy conservation actions, financing, and impacts of energy conservation investments are then presented and a simple scheme of market segmentation is discussed. Some implications of the findings are explored. 16 references, 1 figure, 2 tables.

24970 **(DOE/CE/27460—T2, pp 90) Compatibility of energy efficiency and indoor air quality in residences.** Grimsrud, D.T.; Sextro, R.G.; Turk, B.H. (Lawrence Berkeley Lab., CA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005153.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 7, Proceedings from the panel on social and health factors.

Pollutant concentrations within buildings are frequently higher than those outdoors. Since people spend seventy to ninety percent of their time within buildings, exposures to potentially harmful airborne pollutants [where exposure is approximately the product of the concentration and the time] are dominated by exposures within buildings. A direct coupling is often made between energy efficient buildings and indoor air problems. While this position seems to be intuitively obvious, it is difficult to find field measurements that support the idea because the measurements are difficult and expensive and indoor pollutant concentrations depend on many factors besides ventilation. The assumption is that the concentration is dominated by ventilation, i.e., by a removal process, but many years of study of these problems suggest that concentrations are dominated by sources and source emission rates rather than by ventilation. Field data from projects and programs in which the ventilation rates were changed find that most cases occur in weatherization programs in which thermal losses are reduced by adding insulation and reducing air leakage. In some situations, ventilation rates were deliberately increased, to examine its effect on indoor pollutant concentrations. The changes that have been observed in indoor air quality due to weatherization have been modest. Weatherization can result in an aggregate gain in indoor air quality if simple pollutant measurements occur in the buildings to identify problem structures. Mitigation to correct the problems can result in a net benefit to public health.

24971 (DOE/CE/27460—T2, pp 146-159) **Technical and practical problems of developing and implementing an improved retrofit audit.** McCold, L.N.; Schlegel, J.A.; Hewitt, D.C. (Oak Ridge National Lab., TN). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005153. Contract AC05-84OR21400.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 7, Proceedings from the panel on social and health factors.

Oak Ridge National Laboratory developed a retrofit audit suitable for use in the Low-Income Weatherization Assistance Program. The audit selects the most cost-effective retrofits from among about a dozen building shell and heating system retrofits. The audit was field tested this past winter on 35 single-family houses in Wisconsin. This paper describes the important technical problems encountered in developing and implementing an accurate audit. Two types of technical problems were observed: (1) the best models available for determining the energy savings of some retrofits produce unreliable results and (2) some of the data needed to make accurate energy savings estimates were difficult to obtain or were dependent on auditor judgment. The practical problems included policy or equity questions and difficulties encountered in implementing the audit. This paper discusses the various types of research needed. The discussion also serves to focus attention on the issues, which, it is hoped, will stimulate development of ideas for dealing with these technical and practical problems. 12 references, 1 figure.

24972 (DOE/CE/27460—T2, pp 246-258) **Analysis of lifestyle effects on residential energy use.** Stovall, T.K. (Oak Ridge National Lab., TN). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005153. Contract AC05-84OR21400.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 7, Proceedings from the panel on social and health factors.

To identify the effect of lifestyle trends or relationships on residential energy consumption, seven utilities collected data from about 30 homes in each of 7 locations. For all of these homes, energy consumption data, including submetered space conditioning and water heating energy use, were recorded on a 15 minute basis. Some of the utilities also measured indoor temperature. The utilities collected an assortment of survey information such as family size, house size, and house type. In addition from the Hood River Conservation Project represent 320 homes where submetered energy use and indoor temperature data is available on a 15 minute basis enabled study of a large number of lifestyle effects. However, because this analysis is still in progress, the results presented are preliminary. Indoor temperature and heating and air conditioning energy use and hot water energy use were examined with respect to outdoor temperature, heating system type, family size, house size, and house type. Several trends associated with these variables were identified: homes with central thermostats are more likely to use nighttime temperature setback during the winter than those with individual room controllers; outdoor temperature affects thermostat management during the winter; and hot water use varies seasonally with the variation being most noticeable during the fall months. 3 references, 13 figures.

24973 (DOE/CE/27460—T2, pp 259-280) **Minorities and energy: a review of recent findings and a guide to future research.** Throgmorton, J.A.; Bernard, M.J. III. (Argonne National Lab., IL). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005153.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 7, Proceedings from the panel on social and health factors.

This report discusses the results of the research on minority energy consumption and expenditures being conducted by Argonne National Laboratory for the US Department of Energy's Office of Minority Economic Impact. After summarizing what was known about minorities and energy prior to 1982, the paper briefly reviews current research results in the areas of minority residential and transportation energy use patterns, energy policy assessments, and minority energy business development. The results suggest that, when income and location (transportation) or climate (residential) are statistically controlled, black households differ from nonblack households in their ability or willingness to make long-term capital investments in energy-efficient consumer durables (e.g., automobiles and appliances). Two hypotheses to explain these results are proposed, relating to the culture of minority poverty and structural constraints. Implications of the current results and proposed hypotheses are then briefly discussed. 47 references, 6 figures, 3 tables.

24974 (DOE/CE/27460—T3, pp D.5-D.15) **Energy conservation and property management.** Accomando, R.C.; Aden, G.L. (Coldwell Banker, Los Angeles, CA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

In Doing better: setting an agenda for the second decade: Volume D, proceedings from the panel on existing commercial buildings, new commercial buildings.

Coldwell Banker uses a computerized energy monitoring program account for energy usage in its managed properties. From the building utility bills, the program calculated energy consumed per unit area in the building as well as the energy cost. All energy calculations are performed in BTUs, staggered billing cycles are normalized to a month period, billing rates are standardized, and degree days are factored into the calculations. The paper discusses how this data is used in energy conservation monitoring by Coldwell.

24975 (DOE/CE/27460—T3, pp D.16-D.29) **Energy-related performance of warehouse buildings: a survey.** Burnett, E.F.P. (Univ. of Waterloo, Ontario). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

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Two surveys of warehouse buildings and their energy-related performance are reported upon. The first survey sought to quantify the national stock of warehouse buildings; the second was a detailed assessment of nineteen representative warehousing facilities. The first survey showed that there are at least 48,441 buildings in Canada that could be categorized as warehouses. With a total floor area of more than 60 million square meters and an annual energy consumption in excess of $300 million, warehousing constitutes an important building category: certainly a category of buildings that warrants a focused and comprehensive program of R, D and D. In the second survey, nineteen warehouse buildings were individually examined and, using actual fuel records and the appropriate climatic data their energy-related performance was analyzed. Size-dependent energy consumption indices for space heating and the use of electricity were determined. An attempt was made to characterize the energy-related performance of different sizes of warehouse building in terms of infiltration, enclosure transmission and internal operating conditions. 5 references, 2 figures, 7 tables.

24976 (DOE/CE/27460—T3, pp D.30-D.48) **Measured results of energy conservation retrofits in non-residential buildings: an update of the BECA-CR data base.** Gardiner, B.L.; Piette, M.A.; Harris, J.P. (Lawrence Berkeley Lab., CA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137. Contract AC03-76SF00098.

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Energy consumption data have been compiled for over 300 commercial buildings that have been retrofitted with energy conservation measures. This data base has been updated and expanded since the 1982 Santa Cruz Summer Study; they re-contacted the original contributors of data, updated energy usage and retrofit information, and removed data points with poor quality data. New data sources include schools and hospitals receiving Federal grants, California public buildings, projects undertaken by architecture and engineering firms, and 100 buildings retrofitted under the US Postal Service Phase I project. The distribution of energy savings is examined for the data set as a whole and for subsets by building type. For the 94% of buildings that saved site energy, median savings are 30.8 kBtu/ft^2-year (350 MJ/m^2-year). The median percent reduction is 24.6%. Cost-effectiveness indicators are evaluated for those buildings with retrofit cost data. The median retrofit cost is \$.40/ft^2 (\$.30/m^2) in 1983 dollars. The most common retrofit measures involve HVAC operations and maintenance, and lighting. In many cases energy management in non-residential buildings is a continuing process without clear pre and post retrofit periods. For buildings with a series of retrofits and operating changes they explore simple time-trend analyses as an alternative to a pre/post model. They discuss problems of correcting energy consumption data for changes in weather, occupancy, process loads, and other factors. Significant gaps in the data base are identified, along with suggested steps for dealing with them. 14 references, 6 figures, 5 tables.

24977 (DOE/CE/27460—T3, pp D.49-D.62) **Development of a data base on end-use energy consumption in commercial buildings.** Heidell, J.A. (Battelle Pacific Northwest Lab., Richland, WA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137. Contract AC06-76RL01830.

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Battelle, Pacific Northwest Laboratory, has completed a comprehensive inventory of end-use metered data in commercial buildings constructed using typical design practices. This paper summarizes the results of the inventory and the examination of the types of data measurements desired by building researchers. The inventory and the definition of data needs are used to develop an assessment of end-use data on existing commercial buildings and to determine the need for a public domain data base. This inventory represents the most thorough review of end-use data collected to date. It is based upon over 250 contacts with state energy offices, trade and professional organizations, private architectural and engineering firms, utilities, and federal agencies. In addition, a comprehensive literature search was conducted. The results are summarized by the types of end-uses collected, the data collection method, the time resolution of the data, the availability of the data, related supporting data, and sources of existing documentation. Supporting data reviewed include: building construction details, building operation characteristics, occupancy characteristics, occupancy information, and microclimate data. 15 references, 4 tables.

24978 (DOE/CE/27460—T3, pp D.63-D.72) **Estimates of a commercial/industrial air conditioner cycling program conducted by the Southern California Edison Company.** Jazayeri, A.; Kumm, M.S. (Southern California Edison Co.). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

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The Automatic Powershift (APS) Commercial/Industrial Cycling Program is a direct load management program that has recently been tested at the Southern California Edison Company (Edison). The goal of this program is to reduce commercial and industrial air conditioner load during periods of system peak demand. In this program, a radio-controlled device is attached to the customer's air conditioner that can be used at Edison's option to prevent the operation of the air conditioner for some prearranged percentage of the peak demand period. Prevention of air conditioner operation is referred to as cycling. Three cycling strategies are tested in this program: 30%, 40%, and 50%. In this paper, the results of a regression analysis of load data collected from program participants are reported. In this analysis, the impact of temperature and air conditioner capacity on kW demand and kWh consumption reduction attributable to the program are reported. In addition, the extent to which the reductions vary across four climate zones is also addressed. 4 tables.

24979 (DOE/CE/27460—T3, pp D.73-D.89) **Energy savings in buildings of neighborhood-based non-profit organizations.** Katrakis, J.; Becker, D. (Center for Neighborhood Technology, Chicago, IL). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

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This paper is an interim report of the energy savings realized at buildings owned by agencies which are participating in the Neighborhood Non-profit Energy Program (NNEP) in Chicago. The services provided to each agency include: comprehensive energy audit, preparation of specifications, management of a competitive bidding process, arranging financing through a combination of zero-interest loans and grant, energy management training, and performance monitoring of completed projects for one year. At the end of the second year of the three-year program over 70 agencies are involved in some phase of the program which is administered by the Center for Neighborhood Technology. The participants are neighborhood-based, non-profit organizations (NPOs) encompassing a broad range of community-based social services ranging from settlement homes to out-patient medical facilities. A wide variety of buildings are serviced by this program. Energy savings at the 10 completed and monitored projects range from 2% to 52% for investments with simple paybacks typically in a range of 3 to 9 years. Preliminary results indicate a reasonable correlation between the original audit recommendations, projected savings and costs, and the final implemented measures, actual savings and costs. The results also indicate the important role of monitoring building conditions, and of good temperature control in realizing the projected savings. The maintenance of building system before the retrofit is also important to realizing projected savings. 3 tables.

24980 (DOE/CE/27460—T3, pp D.90-D.102) **Restaurant energy performance.** Mazzucchi, R.P.; Claar, C. (Battelle Pacific Northwest Lab., Richland, WA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137. Contract AC06-76RL01830.

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As part of the Commercial Building Energy Use and Design Program at Pacific Northwest Laboratory, Pennsylvania State University instrumented a set of restaurants selected by the National Restaurant Association to typify the various types of restaurant facilities in the nation. Raw and summary data extracted from on-site minicomputers is provided to PNL on a monthly basis and is analyzed to reveal energy use cause and effect and comparative levels of energy performance. Data have been summarized to reveal the quantities of electricity and natural gas consumed for food preparation, sanitation, refrigeration, lighting, and heating ventilation and air conditioning. This paper provides an assessment of the variability of these quantities across the various sites considering building characteristics, weather, and the level of food service activity. HVAC energy use is found to be highly correlated to exterior temperature, but, variation of total energy use is relatively insensitive to levels of food service activity. This project is the first successful attempt to acquire end-use energy consumption data from a set of buildings using remotely interrogated data acquisition systems. This experience, combined with recent developments in low cost data acquisition technologies, beckons an era of understanding building energy performance with empirical data. Project efforts are managed by Battelle's Pacific Northwest Laboratory with sponsorship from the Architectural and Engineering Systems Branch of the Building Systems Division, US Department of Energy. 10 figures, 2 tables.

24981 (DOE/CE/27460—T3, pp D.103-D.131) **End use consumption patterns and energy conservation savings in commercial buildings.** Schultz, D.K. (California Energy Commission, Sacramento). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

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This report analyzes the commercial energy efficiency audit data collected by the Pacific Gas and Electric Company (PG and E) for the years 1980-1983. Three aspects of commercial sector energy consumption/conservation patterns are analyzed: (1) end use consumption estimates at the time of the initial audit; (2) estimates of the conservation potential savings if all auditor-recommended conservation actions are implemented; and (3) the amount of savings accomplished 1.5 years subsequent to the initial audit. All three levels of analysis provide results for eleven commercial building types, eight electric end uses and four gas end uses. 9 references, 1 figure, 13 tables.

24982 (DOE/CE/27460—T3, pp D.132-D.147) **Analysis of energy savings in the academic buildings at Stockton State College.** Stiles, L.F.; Dirago, E.; Knox, A. (Stockton State College, Pomona, NJ). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

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Students at Stockton State College in the projects oriented physics course - Energy Management - read the utility meters on campus for 90 days on a daily basis. From this data base and 5 years of monthly historical data, the energy savings as a result of a retrofits installed in January, 1983, are estimated. This paper serves the dual purpose of reporting specific energy savings and peculiar thermal bypass at Stockton, and also as a model of a labor-intensive undergraduate students projects course which uses the campus buildings as an object of study. It was found that in the first year at least $17,720 was actually saved compared with $27,558 predicted for the first year season on a $125,475 investment in added-insulation and infiltration/ventilation reduction modifications. Thermal bypass in the curtain wall (metal spandrel with urethane core design) was discovered using a simple test of effective R-values. It was confirmed using an infrared scan. Regression analyses on monthly and daily utility meter readings were used to measure savings and investigate the relative importance of thermal, wind, and occupancy loads, with the surprising result of immeasurable wind load. Free student labor enabled meters to be read daily, and a survey of lighting use to be undertaken. They read blueprints, and performed simple conduction loss calculations. In the process they learned about multiple-variable regression analysis, use of microcomputers and limitations of software. More importantly they learned how to define a problem chose analytic and hardware tools, and come to an answer. That it is done in the context of a real problem resulted in a highly motivated and dedicated group of students. 5 references, 8 figures, 7 tables.

24983 (DOE/CE/27460—T3, pp D.148-D.164) **Decade of energy management at the Ohio State University.** Sullivan, D. (Ohio State Univ., Columbus). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

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The Ohio State University has now completed ten years of an intensive and productive Energy Management Program. Through July 1, 1983, this program produced a 40% reduction in average rate of energy consumption (BTU/Square Foot/Year) and a cost avoidance for the ten year period of 55.7 million dollars from a total investment of under 7 million dollars. Over 50 major buildings have received retrofits resulting from detailed energy analysis. This paper discusses the overall concepts, economics, and decision making process of the program along with a detailed review of a three phase retrofit program for the Biological Sciences Building showing the monitored effectiveness of each of the three phases. The paper also discusses the failures and problems as well as successes emphasizing the importance of concentrating on permanent energy reducing modifications to systems and equipment versus the human dependent concepts that can be lost with the flip of a switch. 3 figures, 1 table.

24984 (DOE/CE/27460—T3, pp D.165-D.179) **Energy effects of electric lighting control alternatives in response to daylighting.** Andersson, B.; Adegran, M.; Webster, T.; Place, W.; Kammerud, R.; Albrand, P. (Lawrence Berkeley Lab., CA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137. Contract AC03-76SF00098.

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Results are presented from a study of south facing roof apertures on two buildings from the US Department of Energy's Non-Residential Experimental Passive Buildings Program. The study was planned to investigate the effectiveness of manual control of the electric lighting system in the buildings, and determine its effects on the heating, cooling, and lighting energy consumption of small daylit non-residential buildings. Data was taken from physical models of the two buildings and from the buildings themselves. The building energy analysis program BLAST was used for the energy analysis of the buildings. Results provide quantitative information on the performance of a variety of electric lighting control strategies in response to natural lighting, including continuous dimming, on/off switching, and the manual control currently in use in the buildings. In both buildings, manual control has provided similar or better energy performance than various automatic control strategies. Factors contributing to this situation are discussed. The daylighting strategies have also shown substantial energy savings over similar, non-daylight buildings. 12 references, 8 figures, 3 tables.

24985 (DOE/CE/27460—T3, pp D.180-D.192) **Passive solar/earth sheltered office/dormitory cooling season thermal performance.** Christian, J. (Oak Ridge National Lab., TN). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137. Contract AC05-84OR21400.

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Continuous detailed hourly thermal performance measurements have been taken since February 1982 in and around an occupied, underground, 4000 ft^2 office/dormitory building at the Oak Ridge National Laboratory in Oak Ridge, Tennessee. This building has a number of energy saving features which have been analyzed relative to their performance in a southeastern US climate and with respect to overall commercial building performance. This analysis documents cooling season performance, as well as effects of earth contact, interior thermal mass, an economizer cycle and interface of an efficient building envelope with a central three-ton heat pump. The Joint Institute Dormitory obtains a cooling energy savings of about 30% compared with an energy-efficient, above-grade structure and has the potential to save as much as 50%. The proper installation of the overhang, interior thermal mass, massive supply duct system, and earth contact team up to prevent summertime overheating. From May through September, this building cost a total of $300 (at 5.7 cents/kWh) to cool and ventilate 24 hours per day. Besides thermal performance of the building envelope, extensive comfort data was taken illustrating that at least 90% of the occupants are comfortable all of the time according to the PMV measurements. 6 references, 11 figures.

24986 (DOE/CE/27460—T3, pp D.193-D.202) **Petroleum corporation of Jamaica building.** Dubin, F.S.; Saurwein, L.G. (Dubin-Bloome Associates, P.C., New York, NY). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

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The Petroleum Corporation of Jamaica (PCJ) authorized Marvin Goodman and Associates to design their headquarters building with Dubin-Bloome Associates retained as the architectural, mechanical, electrical and energy consultants for the PCJ Building. The objective of the building design team was to select materials and develop systems and plans for a building that would use less than 25,000 Btu/sq ft/yr within the established budget and consistent with the owners' program. The building design deserves recognition by virtue of its innovative use of energy management principles. Virtually no data had been accumulated for Jamaica and other semi-tropical and tropical climates pertaining to energy management and alternate energy use. The design team compiled available information to establish a data base. 4 tables.

24987 (DOE/CE/27460—T3, pp D.203-D.216) **Commercial building cogeneration opportunities.** Eto, J.H. (Lawrence Berkeley Lab., CA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137.

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The technical and economic characteristics of a successful cogeneration system can be easily outlined; analysis of the opportunities for such systems in commercial buildings, however, is complicated by the number of interdependent trade-offs that must be made in any given application. One general statement of the problem is that an understanding of the net impact of the trade-offs requires an engineering/economic analysis that can capture the dynamic relationships between the thermal and electrical requirements of commercial buildings, the operating characteristics of the cogeneration equipment, and the utility interface to this operation. The DOE-2.1 building energy analysis tool is used to analyze the returns to cogeneration systems for two building types located in five US cities. For these systems, the effects of system sizing and operating strategies are examined using actual rate schedules. They conclude that cogeneration is best thought of as fuel-switching strategy and that, in this context, the driving force for cogeneration opportunities in commercial buildings is the levels and relative prices of the fuel and the electricity that are being substituted. 15 references, 4 tables.

24988 (DOE/CE/27460—T3, pp D.217-D.242) **Analysis of daylighting as a conservation strategy in hot climates: the development of a daylighting analysis tool for Singapore.** Levine, M.D.; Turiel, I.; Curtis, R. (Lawrence Berkeley Lab., CA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137. Contract AC03-76SF00098.

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The use of daylighting - integration of window and lighting systems in buildings - has the potential to substantially reduce energy use in a highly cost-effective manner. This conservation strategy is particularly suitable for hot, sunny climates such as Singapore. This paper represents a detailed assessment of effects of daylighting on energy use in Singapore. It carries the analysis to the point of development of a tool that has the potential for greatly simplifying the calculational procedures for evaluating daylighting. A large number of computer simulations using the DOE-2 computer code have formed the data base from which an approach has been developed that allows results of the energy analysis to be generalized from one building to another. Singapore is used as a test case, with the intent to apply the approach to other locations in the future. 7 references, 8 figures, 2 tables.

24989 (DOE/CE/27460—T3, pp D.243-D.257) **Peak demand savings from daylighting in commercial buildings.** Selkowitz, S.; Arasteh, D.; Johnson, R. (Lawrence Berkeley Lab., CA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137. Contract AC03-76SF00098.

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In many regions in the US, load management and peak demand issues are of greater importance to utility planners than are reductions in energy consumption. Proper daylight utilization in commercial buildings can substantially reduce peak demand and increase energy savings. However, to determine optimum design strategies for controlling electrical demand, it is first necessary to understand the often conflicting impacts of fenestration on lighting and cooling loads. They use an hour-by-hour energy simulation model (DOE-2.1B) to evaluate peak demand components and net effects in daylighted and nondaylighted buildings. More than 5000 parametric simulations were generated for prototypical office building modules containing both horizontal and vertical glazing, and located in 16 US cities. From these simulations they draw conclusions about the effects of daylighting on peak demand for a range of climate types, orientations, fenestration areas, glazing shading coefficients and visible transmittances, U-values, lighting power densities, and lighting control strategies. Results for Los Angeles are briefly compared to results for the climatic extremes of Lake Charles, Louisiana (cooling-dominated), and Madison, Wisconsin (heating-dominated), and then discussed in detail. They also briefly describe studies in progress to measure peak load impacts of fenestration using an outdoor test facility and occupied buildings. 16 references, 10 figures, 1 table.

24990 (DOE/CE/27460—T3, pp D.258-D.274) **Summary report of BECA-CN: buildings energy-use compilation and analysis of energy-efficient new commercial buildings.** Wall, L.W.; Piette, M.A.; Harris, J.P. (Lawrence Berkeley Lab., CA). Aug 1984. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005137. Contract AC03-76SF00098.

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Energy consumption data have been compiled and analyzed for 124 new commercial buildings. Of these, 83 represent measured performance data on new buildings in actual operation; the remainder are design values for buildings under construction or recently completed. Many of these buildings are at the forefront of energy-efficient design (energy award winners). A majority of buildings with measured performance data achieved site energy consumption levels in the range of 30 to 70 kBtu/ft^2-yr (311 to 795 MJ/m^2-yr), or 100 to 220 kBtu/ft^2-yr in resource energy units (1135 to 2497 MJ/m^2-yr). Even lower design consumption levels, in the range of 20-50 kBtu/ft^2-yr (227 to 568 MJ/m^2-yr), site energy, are predicted for several new office buildings still under construction. Offices and schools are the dominant building types in the data base; over 70% of the buildings have floor areas larger than 50,000 ft^2 (4647 m^2). A majority of the buildings in the present compilation are government-owned and occupied. They discuss specific energy-saving features and design strategies. Summary tabulations for other building characteristics such as type of energy, year of construction, location, and climate zone are presented. Cost data for the buildings have been relatively scarce, but preliminary results indicate that it is possible to build an energy-efficient commercial building within the same range of costs as for conventional structures. 9 references, 7 figures, 3 tables.

24991 (DOE/CE/27460—T4, pp 5-17) **Evaluation of a utility weatherization program: using a PRISM database for weatherization policy.** Airriess, E.G. (Wisconsin Power & Light Co., Madison). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

This paper reviews a utility weatherization program ordered by the Public Service Commission of Wisconsin in 1982 and administered by the major natural gas and electric utilities to reduce energy bills of low-income customers. The program was evaluated between 1985 and 1986 to determine the level of energy savings realized from it. Evaluation of the program was approached cautiously. There was interest in the evaluation results to address broader policy questions: (a) what were the potential energy savings, (b) what were the best weatherization measures to install, and (c) how much could customers bills be reduced? Not only were these questions being asked by utilities, but they were being asked by the state legislature to determine state involvement in weatherization and by advisory groups concerned with weatherization guidelines. The process undertaken to accomplish the evaluation and the subsequent results are described. Information from the evaluation effort provided opportunities unforeseen at the time the evaluation was undertaken The dividends from using the Princeton Scorekeeping Method (PRISM) in retrospect outweigh the considerable efforts to do the evaluation, particularly as subsequent evaluations are undertaken. 7 references, 2 figures, 6 tables.

24992 (DOE/CE/27460—T4, pp 18-29) **Elmhurst residential rebate program: issues in the conduct of a comprehensive evaluation.** Bronfman, B.H.; Horowitz, M.J.; Lerman, D.I.; Petersen, F.; Elizalde, J. (International Energy Associates, Ltd., Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

This paper discusses three evaluation issues in a process and outcomes evaluation of an experimental residential weatherization program. Two programs were run simultaneously in a small utility in suburban Tacoma, Washington. Households requesting energy services were randomly assigned to the experimental or conventional weatherization program. Three evaluation issues were examined which arose during the course of this program: (1) the role of the evaluator in situations where program management responsibilities are in transition; (2) the effect of major program changes on the evaluation; and (3) the impact of supplementing data on the analysis results. 8 references, 4 tables.

24993 (DOE/CE/27460—T4, pp 30-41) **Evaluation of informational conservation programs for commercial and industrial customers.** Coates, B. (Seattle City Light, WA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

Evaluations of two conservation programs (the Walk-Through Survey Program and the Energy Management Partnership Program) for commercial and industrial customers found that both program increased conservation activities and both were cost effective. Other findings were that (1) the Walk-Through Program saved energy only for large participants, (2) average savings for this program was 23,179 annual kWh and for the Energy Management Program was 122,109 annual kWh. The evaluations demonstrate the value of the information programs, and they illustrate key evaluation issues which are encountered in evaluating conservation programs for commercial and industrial customers. These include the usefulness of telephone interviews and evaluation designs for analyses. 11 references, 4 tables.

24994 (DOE/CE/27460—T4, pp 42-54) **Final evaluation of an RCS program alternative: the Santa Monica energy fitness program.** Egel, K. (City of Santa Monica, CA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

The Santa Monica Energy Fitness Program, used new techniques designed to increase participation in the RCS Program by utility customers, particularly by target groups, as well as improve the energy savings achieved by participants. These target groups include senior citizens, low-income residents, and renters of multifamily housing. Two particularly important techniques were the use of a door-to-door canvass and the completion of a direct service home energy audit, which includes the actual on-site installation of energy saving devices in the participant's home. A summary of the unique elements of the Energy Fitness Program's approach describes the components of the experimental design by which the Santa Monica effort was completed and presents the final results or the evaluation performed to measure the program's effectiveness. The evaluation discussion will particularly focus on program participation and net savings in natural gas, electricity, and water resources achieved by participants. 6 tables.

24995 (DOE/CE/27460—T4, pp 55-69) **Best land plans of mice and men: a process evaluation of the Hood River Conservation Project.** French, S.; Peach, H.G. (Pacific Power & Light, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

The Hood River Conservation Project weatherized almost 3000 homes in two years. This feat was accomplished in addition to the installation of high-level measures and simultaneous implementation of a research project, all in a small rural community. It is evident that this program was unlike any other in the intensity of its demands. Though extensive planning took place before the project began, implementors were often forced by unanticipated occurrences to change rapidly to adapt to new situations. This process evaluation discusses some of the changes encountered and lessons learned in the course of project implementation. Topics include: background and structure of the project, field office set-up, staffing structure, weatherization implementation, contractor relations, inter-organizational, and evaluation issues. 4 references, 3 figures.

24996 (DOE/CE/27460—T4, pp 70-83) **Dynamics of energy savings due to conservation programs.** Hirst, E.; Keating, K. (Oak Ridge National Lab., TN). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

The dynamics of program energy savings have two aspects. The first involves changes in savings for households who participated in a particular year. Their total and net savings depend on changes in electricity prices, incomes, general awareness of energy issues, and other conservation programs. Natural gas data from participants and nonparticipants in home energy audit programs in California, Michigan and Minnesota show, for example, small increases in both net and total savings between the first and second post-audit years. Data from evaluations of financial incentive programs for residential retrofit in the Pacific Northwest, on the other hand, show increases in total electricity savings and declines in net savings between the first and second year after retrofit. The second aspect concerns changes in energy reductions over time for different cohorts of participants due to changes in the characteristics of participants, the conservation program itself, and the external environment. For example, the one-year net electricity savings for participants in the Bonneville Power Administration Residential Weatherization Program declined from about 4000 kWh/year for participants in 1981 and 1982 to 2500 kWh for participants in 1983 and 1984. 24 references, 4 figures, 2 tables.

24997 (DOE/CE/27460—T4, pp 84-94) **Evaluation of Madison Gas and Electric Company's weatherization assistance program for low-income customers.** Hobbie, L.K.; Stellner, J.C.; Stoffs, R.K. (Madison Gas and Electric Co., WI). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

Madison Gas and Electric Company offers weatherization assistance to its low-income customers in the form of Conditional Grants, which are designed to address the weatherization and efficiency needs of individual homes. Specifically, the grants include insulation, infiltration, and equipment efficiency improvements judged cost effective for a given home based on estimated paybacks. This paper evaluates that program after its first year of operation. The evaluation used actual preprogram and post-program consumption to estimate changes in natural gas consumption among first-year participants. The paper describes methods and analyses used in the evaluation. It discusses briefly why certain methods were chosen, their strengths, and limitations. It also discusses preliminary findings of the evaluation, conclusions from those findings, and some directions for future research. At its conclusion, the paper presents an approach evaluation staff developed in the aftermath of this particular project to improve its process for conducting future evaluations. 2 references, 5 figures, 1 table.

24998 (DOE/CE/27460—T4, pp 95-104) **Issues and results from the evaluation of the adoption and enforcement of model conservation standards.** Keating, K.M.; Lerman, D.I.; McCutcheon, L. (Bonneville Power Administration, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

A multi-faceted evaluation of the adoption and enforcement of building codes and utility hook-up requirements in jurisdictions that adopted the Northwest Power Council's Model Conservation Standards found that evaluations of building energy codes present several problems that are not encountered in the evaluations of retrofit programs. In addition to a process evaluation of implementation of the codes, there were differences between enforcement, compliance, and energy impacts. This paper describes the evaluation of the implementation of building codes. It covers training, costs, procedures, and problems. Special research efforts were necessary to deal with evaluating compliance. Detailed inspections, blower door tests, and infrared video thermography tests were used. The effect of noncompliance on energy use was estimated based on as built conditions. Finally, the design of the impact evaluation based on billing records is discussed. 11 references.

24999 (DOE/CE/27460—T4, pp 105-115) **Evaluating Michigan's new expanded home repair and weatherization program: procedures, results and issues.** Kushler, M.G.; Witte, P. (Michigan Energy Administration, Lansing). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

The Home Repair and Weatherization Program specifically targets the highest energy consuming households on public assistance and coordinates the services of several different state agencies, the utilities, and private contractors, in an effort to reduce heating fuel consumption. The program is authorized to spend up to $5,000 per household of home repairs and weatherization services. This paper highlights results of a comprehensive evaluation of the first group of participants. Sources of data include (1) agency records concerning repair/conservation measures installed and their cost; (2) telephone surveys concerning demographic and behavioral information; and (3) actual utility fuel consumption records. Participants are compared with a de facto hold-out comparison group samples from service waiting lists. The data indicate that the program participants achieved nearly a 30% reduction in space heat fuel use, with an average direct cost of repair and weatherization of $3518. (The no-service group space heat fuel use declined by one percent during the same time period.) The results are also compared with a recent study by these authors of the regular Low-Income Weatherization Assistance Program in Michigan, and various related evaluation issues are discussed. 9 references, 2 tables.

25000 (DOE/CE/27460—T4, pp 117-128) **Results from Oslo Electricity Works' energy conservation program.** Moen, J. (Oslo Electricity Works, Norway). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

The Oslo Energy Conservation Program targeted a 15% reduction in consumption (1500 GWh) by the year 2000 with a program of grants and loans for subscribers. Calculations show that the overall program is profitable. A new data base management system provides energy conservation data information, and will help to identify and analyze important elements in subscriber's decision making processes. Both major and minor changes in the program have come about as a result of the evaluations which make it easier for subscribers to understand what is available and for the program managers to analyze the performance of projects. 5 references, 2 figures, 4 tables.

25001 (DOE/CE/27460—T4, pp 144-157) **Truncation bias in energy demand equations: effects of missing survey data.** Skumatz, L.A.; Holt, S.; Barnes, R.S.; Ong, P. (Pacific Gas and Electric Company, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

Missing data is an important problem in survey databases. Some standard statistical packages exclude observations with missing data. Using truncated samples for saturations or model-building can lead to bias. Exploratory work on the extent and consequences of the bias was performed at PG and E using a large, residential customer database containing response on structural characteristics, appliance holdings, and demographic information. The results of a probit analysis showed that there were systematic, predictable differences between those respondents who are informed about energy characteristics and those who are not. An analysis of the extent of bias introduced in using truncated samples and samples augmented via hot deck techniques for saturations and model-building was performed. The work led to suggestions on the most effective methods for imputing information for missing data. 2 tables.

25002 (DOE/CE/27460—T4, pp 158-169) **Evaluating the economic effects of the low-income weatherization program: a conceptual and methodological framework.** Walsh, R.W.; Crown, W. (Univ. of Vermont, Burlington). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

This paper provides a conceptual framework and discusses methodological issues surrounding the estimation of micro- and macroeconomic impacts of the Low-Income Weatherization Program. Important microeconomic impacts include (1) expenditure of program funds on materials and support services and (2) an effective income gain realized by program participants through induced energy savings. These impacts stimulate economic activity in industries affected by changes in demand for weatherization products and increased purchases of goods and services by participating households. Methodological and data quality issues involved in deriving estimates of these impacts are presented from two broad perspectives: (1) the consumption effects of the program, including (a) materials and support and (b) induced demands of program participants and (2) the output and employment effects. The implications for conducting economic evaluations of the Low-Income Weatherization Program along the conceptual lines include considerations in cost-benefit analysis, application in principle to other energy conservation practices and the utilization of energy conservation evaluation research results. 20 references, 1 figure.

25003 (DOE/CE/27460—T4, pp 170-181) **ELCAP residential base study sample: a basic characterization.** Windell, P.A. (Bonneville Power Administration, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

The End-use Load and Conservation Assessment Program (ELCAP) sponsored by the Bonneville Power Administration is among the first large scale fuel monitoring projects. This paper is a product of initial analytical work directed at assessing the results of the residential sampling and recruiting efforts, and is intended as an early contribution to the development of large scale monitoring protocols. Following a brief overview of the ELCAP and a summary description of the residential sample selection process, the paper then presents an initial characterization of the final residential Base Study sample. The paper concludes with an assessment of the relative success of the residential sample selection strategy in achieving the original objectives for the study. 11 references, 2 figures, 11 tables.

25004 (DOE/CE/27460—T4, pp 182-184) **Conducting a residential energy financial program.** Dubester, L. (Center for Ecological Technology, Pittsfield, MA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

The Center for Ecological Technology (CET) has helped to develop and deliver energy conservation programs to Berkshire County by identifying obstacles and myths which kept people for seeking help. CET found that a program must provide objective information, consumer protection, education, advocacy, financing assistance, and quality control if it expects to gain the public's confidence.

25005 (DOE/CE/27460—T4, pp 185-189) **Innovative financing for energy conservation.** Lambert, F.S. (Office of State and Local Assistance Programs, Washington, DC). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

A review of DOE state and local grant program identifies four types of activities designed to encourage the use of innovative financing for energy conservation projects: demonstration projects, analyses of innovative financing in various applications, grants to states for services related to innovative financing, and efforts to eliminate legal and regulatory barriers. A survey collected data on eight forms of financing: direct loan, loan interest reduction, lease, lease purchase, shared savings, energy services contract, guaranteed cash contract, and conservation incentives. The study found widespread use of the eight financing methods. 2 tables.

25006 (DOE/CE/27460—T4, pp 190-195) **Utility program by any other name... the perceptual space for considering participation.** Feldman, S.; Finkbeiner, C.T.; Berrigan, J.A.; Lewis, L. (National Analysts, Philadelphia, PA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005156.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 10, Proceedings from the panel on program evaluation.

Sixty-four residential electrical utility customer rated each of sixteen space heating and cooling technologies on twelve different attributes, as part of pilot research for a national area probability survey of customer preference and behavior, sponsored by the Electric Power Research Institute. Dissimilarities among technologies were used to determine the range of appliances that could be included in analyses of tradeoffs made by customers when they consider relevant utility programs, and the potential generalizability of consumer decisions regarding participation in such programs. These dissimilarities were computed at distances between technologies, developed from the mean attribute ratings for each technology. Analyses were conducted for the eleven heating and five cooling technologies independently, and for the entire set of sixteen taken together, to determine perceptual clustering of the technologies. Interpretation of the clusters was based on analyses of the original attribute ratings. The results indicate the need to consider both engineering factors and perceptual factors in understanding customer judgment. 5 tables.

25007 (DOE/CE/27460—T6, pp 9.7-9.10) **Effects of energy conservation measures: results from a Swedish before-after study.** Anderlind, G.; Bengtsson, L.; Karlsson, H.O.; Rundberg, P.; Hoeglund, L.O.; Rolen, C.; Hjalmarsson, C.; Norlen, U.; Jonsson, J.A.; Nordlander, J.; Johansson, H. (Lund Institute of Technology, Sweden). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

To estimate the average savings of a number of energy conservation measures a before-after study in 306 randomly selected single family and multifamily houses from four different parts of Sweden was performed. The field work was carried out during two to three heating seasons including weekly measurements of energy consumption, indoor and outdoor air temperatures, wind speed and insolation. The houses were also inspected at site. 2 tables.

25008 (DOE/CE/27460—T6, pp 9.11-9.13) **Evaluating the performance of energy conservation products. What are the issues?.** Biemer, J.R.; Auburg, C.D. (Bonneville Power Administration, Portland, OR). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

Bonneville Power Administration (BPA) has studied the performance of a variety of energy conservation products including: water heaters, solar water heating systems, refrigerators, electric motors, heat pump water heaters, and windows. The authors have observed that a number of important issues are common across the whole spectrum of products. There are typically three related but distinct sources of performance information: predictive techniques, and monitoring data and ratings. 1 figure, 1 table.

25009 (DOE/CE/27460—T6, pp 9.14-9.24) **Geographic and seasonal effects on residential end-use loads.** Brodsky, J.B.; Gray, B.M.; Guliasi, L.; Kanter, M.; Reuss, M.J. (Pacific Gas and Electric Co., San Francisco, CA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

Pacific Gas and Electric Company's Appliance Metering Project (AMP) is designed to provide information on residential end-use load patterns. Approximately 850 households in northern and central California have been metered to measure the loads of such end-uses as air conditioning, space heating, water heating, refrigeration, clothes drying, and cooking. This paper presents the sampling methodology and implementation procedures used in the Appliance Metering Project and discusses the results of an analysis of end-use load shapes. Appliance saturations, household electricity consumption, and end-use load shapes are analyzed by season (summer versus winter) and by geographic zone (California's interior, central valley versus the remaining PG and E service territory). 3 figures, 1 table.

25010 (DOE/CE/27460—T6, pp 9.25-9.41) **Comparison of Princeton scorekeeping method results with submetered consumption data: empirical and theoretical observations.** Burnett, M.S.; Lesser, J.A. (Pacific Northwest Utilities Conference Committee, Portland, OR). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

The Princeton Scorekeeping Method (PRISM) is a model which weather normalizes utility bills. The performance of PRISM is investigated empirically using submetered data from 40 homes in Oregon. Comparisons are made between submetered data and PRISM results for baseload, space heat, temperature sensitivity coefficient, and reference temperature. The submetered data makes it possible to test theoretical aspects of PRISM. PRISM is found to have a bias that is relatively minor in magnitude and easily correctable: it overstates the sensitivity of energy use to weather. The theoretical basis for this problem is the inclusion of non-temperature sensitive seasonal baseload consumption in its determination of the temperature normalizing (beta) coefficient. This component of baseload, best exemplified by lighting, exhibits a seasonality which is coincident with, but independent of, temperature. The result is that PRISM estimates of conservation savings are not entirely independent of weather. Savings are overstated if the second year is colder than the base year, and vice versa. Fortunately, the magnitude is small, approaching 10% of savings only under extreme circumstances. The theoretical basis for the phenomenon is presented, and an approach for correcting the bias is proposed. 2 figures.

25011 (DOE/CE/27460—T6, pp 9.42-9.44) **Predicting hourly residential air conditioning load.** Carl, M.E.; Gray, B.M. (Pacific Gas and Electric Co., San Francisco, CA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

End-use modelling has recently become more popular relative to other electricity demand forecasting techniques such as the aggregate econometric and trending, because the end-use approach better represents the manner electricity is consumed. One of the major residential end-uses is the central air conditioning load which drives the peak growth of a summer peaking utility, such as PG and E, causing the weather-related uncertainty in resource planning. As a result, PG and E sponsors an end-use metering project to better understand this weather-sensitive load. The total air conditioning load for the residential class is the result of invoking the following accounting identity: Total load = Total residential customers, saturation rate, hourly use per air conditioner owner. This paper illustrates a practical method to estimate the hourly use per air conditioner owner. Thus, the hourly prediction enters directly into the end-use forecasting framework. 3 figures.

25012 (DOE/CE/27460—T6, pp 9.45-9.57) **Measured end-use savings vs predicted savings of a commercial lighting conservation retrofit.** Cleary, C.; Schuldt, M. (Seattle City Light, WA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

An analysis of a major lighting system modification in an all-electric retail store makes comparisons of the measured hourly end use data obtained in one year before and after the installation to provide a detailed assessment of the impact of the retrofit on end use energy consumption, annual and seasonal daily load shapes, and annual peak day consumption. Overall, the annual total consumption decreased 32%, from 34.3 kWh/ft^2 to 23.4 kWh/ft^2. Lighting consumption, the largest annual load, decreased 33% from 24.1 kWh/ft^2 to 16.2 kWh/ft^2. A comparison of the measured energy savings with the DOE 2.1B simulation results based on actual weather data for end use energy consumption found that actual energy savings were greater than predicted, primarily because cooling and heating loads did not change as predicted by the model. The reduction in the cooling load from the pre-retrofit level of 5.9 kWh/ft^2 to 2.5 kWh/ft^2 was greater than the level of 3.1 kWh/ft^2 predicted by the model for the post-retrofit period. The pre-retrofit measured level of the heating load (1.2 kWh/ft^2) did not increase to 2.1 kWh/ft^2 as predicted by the model, but remained at approximately the same level. The implications of using simulation results for utility conservation program planning are discussed. 7 figures, 4 tables.

25013 (DOE/CE/27460—T6, pp 9.58-9.74) **Comparison of four versions of the DOE-2 energy analysis program.** Crawley, D.B.; Taylor, Z.T. (Pacific Northwest Lab., Richland, WA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155. Contract AC06-76RL01830.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

In the last five years, four new versions of the DOE-2 building energy simulation program have been released on a regular basis by Lawrence Berkeley Laboratory - DOE-2.1, DOE-2.1A, DOE-2.1B, and the most recent, DOE-2.1C. In this paper, the variation in results from these four versions of DOE-2 are compared and contrasted for three example office buildings in five locations in the Tennessee Valley region. Variations in annual total and component building energy performance, and the possible reasons for the variances are discussed. Variation in predicted building and plant peak loads are also shown. 9 references, 9 figures, 1 table.

25014 (DOE/CE/27460—T6, pp 9.75-9.87) **Instrumented buildings: experiences in obtaining accurate data.** DeCicco, J.; McGarity, A.; Norford, L.; Ryan, L. (Princeton Univ., NJ). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

In field studies of large buildings, a great deal of effort has been required to assure data of sufficient qualify for scientific investigations of energy consumption. In this paper the authors discuss some of the pitfalls which they have encountered in the course of monitoring buildings. They then describe the methods they have developed to climb out of them and avoid them in the future. The problems have included: electrical storm damage to a hardwired, distributed-intelligence data acquisition system; thermal instability and limited resolution of solid-state temperature measurement electronics; troubles with pulse counters for gas and electric meters; difficulties in placement and calibration of flow meters. Their ways of dealing with such problems are: criteria for selection, redundancy, and placement of sensors; calibration procedures; data cross-checking; quick-look plotting and tabulation of data. Many of their quality assurance techniques have been embodied in software developed for acquisition, archival, extraction, and preliminary analysis of the data from their buildings. This paper highlights their experiences in monitoring buildings. 2 references, 2 figures.

25015 (DOE/CE/27460—T6, pp 9.88-9.100) **Issues concerning the use of weather correction methodologies by schools and local governments to determine energy savings.** Duerr, M.; Cornwall, B. (Duerr Evaluation Resources, Chico, CA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

Many school districts and local governments have been collecting and analyzing energy use data to determine the effectiveness of energy programs. The energy accounting procedures used have generally not included corrections for annual variations in weather. Thus, these methods often lead to erroneous conclusions concerning changes in energy consumption. To increase the reliability of the calculations, state energy offices have encouraged the use of methodologies that correct for changes in weather. This paper reviews the methods generally in use, makes conclusions regarding their relative effectiveness, and makes recommendations to schools and local governments about specific situations in which different procedures are appropriate. 13 references, 2 figures.

25016 (DOE/CE/27460—T6, pp 9.101-9.105) **Tale of two methods: analysis of energy use data from multifamily retrofit tests.** Dunsworth, T.S.; Koehler, M.J.; Hewett, M.J. (Minneapolis Energy Office, MN). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

In order to determine the savings and cost-effectiveness of various types of energy conservation retrofits, the Minneapolis Energy Office sought analytical methods that would give accurate and reliable savings estimates regardless of changes in weather between test periods. The authors describe their experiences with the Princeton University PRISM program run on a mainframe computer and their own system of a spread sheet and two auxiliary programs that run in-house on a personal computer. Both methods can give useful results in multifamily retrofit tests, and tend to complement each other by dealing with different sorts of cases, but there are some cases which work better with one method. 7 references.

25017 (DOE/CE/27460—T6, pp 9.106-9.114) **PRISM research: yesterday, today, and tomorrow.** Fels, M.F.; Hurvich, C.M.; Reynolds, C.L. (Princeton Univ., NJ). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

PRISM, the Princeton Scorekeeping Method, is a statistical procedure which uses available data to monitor energy conservation in housing. The PRISM software has been used for the measurement of energy savings in a wide variety of energy conservation programs, involving use of all major fuels for heating, in multifamily as well as single-family buildings, over a wide range of heating-dominated climates in the US, and for aggregate as well as individual-building consumption. Applications to date, by Princeton and by other scorekeeping groups, are summarized. In addition, current and future directions for PRISM research are identified in the context of anticipated applications. 23 references, 2 figures.

25018 (DOE/CE/27460—T6, pp 9.115-9.128) **Taking PRISM one step further: the refraction method to decompose energy savings.** Goldberg, M.L.; Fels, M.F. (Princeton Univ., NJ). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

A simple refraction method extracts energy conservation trends from energy billing data. Energy savings estimated by the Princeton Scorekeeping Method (PRISM) are decomposed into physically meaningful components. In addition, indoor temperature changes are inferred, and the effect of such changes on energy savings is quantified. Two test applications demonstrate the method. (1) Individual-house billing data for a large number of gas-heated houses in Wisconsin suggests the dominant role of structural retrofitting in the energy savings achieved by a low-income weatherization program. (2) Utility aggregate data for nearly one million gas-heated houses in New Jersey points to the importance of lower thermostat settings in the years immediately following the oil embargo, and, since 1980, to a substantial decline in consumption by appliances including water heaters. More recently, the role of structural retrofitting seems to be increasing, but a takeback effect due to a concomitant increase in indoor temperatures may be eroding the resulting savings. The physical reasonableness in these test cases reinforces the potential of energy billing data to enhance the understanding of energy conservation. 8 references, 1 figure, 2 tables.

25019 (DOE/CE/27460—T6, pp 9.129-9.131) **Statistical building energy usage prediction methodology.** Haberl, J.S.; Claridge, D.E. (Univ. of Colorado, Boulder). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

Ten parameters were found to significantly effect the University's Rec Center's energy consumption. These parameters are grouped according to whether they are environmental parameters (EP), operational parameters (OP) or system parameters (SP). Each of the seven statistical meters (SCONs) are then composed of combination of parameters that yielded the highest R^2. The resultant parameters and the SCONs as well as the inter-correlation matrix among the parameters are summarized. The seven SCONs are capable of tracking the daily energy consumption to within 9 to 12%. The methodology developed is the result of studies begun in 1980. Current work involves streamlining the process, creating user-friendly I/O, and extending the methodology to additional buildings on campus. 4 references, 3 figures, 1 table.

25020 (DOE/CE/27460—T6, pp 9.132-9.145) **Multivariate statistical assessment of meteorological influences on residential space heating.** Hadley, D.L.; Tomich, S.D. (Pacific Northwest Lab., Richland, WA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

The relationship between residential space heating in four residences in the Pacific Northwest and the external meteorological determinants of the space heating variability were investigated using the statistical techniques of principal component analysis (PCA) and multivariate regression analysis. The PCA identified 3 significant, uncorrelated components that were linear combinations of the 6 original meteorological variables. The first component, dominated by the outdoor temperature, accounted for between 65% and 69% of the variability in the original meteorological data and explained between 55% and 85% of the variability in the daily total space heating consumption. The first three principal components combined to explain over 95% of the variability in the data and up to 90% of the variability in the space heating. 9 references, 2 figures, 7 tables.

25021 (DOE/CE/27460—T6, pp 9.146-9.154) **Microcomputer algorithm for degree-days to an arbitrary base.** Holt, D. (Dept. of Energy, Washington, DC). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

For energy-efficient buildings, many analysts need estimates of annual heating degree-days measured from a base temperature different than the conventional 65°F. This paper presents an algorithm to estimate annual heating degree-days (AHDD) from an arbitrary base temperature. The algorithm may be used with a pocket calculator, or may be incorporated in microcomputer modeling programs that analyze energy use in buildings. It is based on a physical climate model with two parameters: the annual average temperature, and the average temperature of the coldest month. Algorithm results are compared to degree-day data published by the

Los Alamos National Laboratory (LANL) for every state in the US and for four base temperatures. The average difference between algorithm estimates and LANL data is 15 AHDD, with a standard deviation of 168 AHDD. This standard deviation is about half the standard deviation of year-to-year fluctuations in AHDD in most parts of the US. The correlation coefficient between algorithm data and the comparison data is 0.998 over the range 0-20,000 AHDD, and 0-6000 annual cooling degree-days. 4 references, 2 figures, 3 tables.

25022 (DOE/CE/27460—T6, pp 9.155-9.169) **Short-term monitoring methods used in documenting the performance of individual efficiency improving measures for space heating systems in multifamily building.** Katrakis, J.; Mathur, A.; Kathuria, D.; Heiman, R. (Center for Neighborhood Technology, Chicago, IL). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

There are significant opportunities for making cost-effective energy saving improvements to the existing space heating systems in older multifamily buildings in Chicago. Four promising energy conservation (ECH) measures for single-pipe steam buildings are: thermostatic boiler controls; balancing by proper vent treatments; derating the gas and air input to the boiler; and vent dampers. This paper presents the preliminary results of a review of some of the short-term monitoring methods used in a Gas Research Institute sponsored study of space heating improvements in multifamily buildings. It also presents preliminary performance results from the first half-season evaluation of the four ECMs. The results indicate (1) that a weekly reading of max-min thermometers in each apartments has a level of precision comparable to hourly and weekly averages of continuous data from each apartment, and that it is feasible to use short-term monitoring periods to discern savings of greater than 20%. The performance of these various Energy Conservation Measures (ECMs) is documented by measuring changes in boiler gas consumption and by performing least-square fit against outdoor air temperature. Measured savings for the four test ECMs range from 8 to 45%. The level of confidence in the documented savings is satisfactory except for the vent damper. 6 references, 4 tables.

25023 (DOE/CE/27460—T6, pp 9.170-9.185) **Energy management systems as a source of building energy performance data.** Le Coniac, P.; Flora, D.; Akbari, H. (Lawrence Berkeley Lab., CA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155. Contract AC03-76SF00098.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

Energy Management Systems (EMSs) are becoming increasingly popular devices for the control of large buildings, where compilation and analyses of hourly energy use, weather, and occupancy information can provide a quick and cheap method of obtaining an electrical energy end-use breakdown without actually submetering end-uses such as lighting, heating, and cooling. The capabilities of existing EMSs as a key to end-use characterization of an industrial/commercial building in Milpitas, California, have been evaluated. Spreadsheet programs break down the daily and hourly total building electricity use into their major end-use constituents. The calculated total building electricity use agrees with measured data fairly well (within 10%) for the daytime hours of building operation where schedules and occupancy are known. It is concluded that gathering information with even simple EMSs can be a useful, logical, and relatively inexpensive step toward understanding present energy use and revealing areas of load management and conservation. 8 references, 5 figures, 1 table.

25024 (DOE/CE/27460—T6, pp 9.186-9.188) **Commercial building energy use monitoring for utility load research.** Mazzucchi, R.P.; Caldwell, L.E. (Pacific Northwest Lab., Richland, WA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

The authors describe the most current versions of the metering and characteristics data collection protocols in use for the End-Use Load and Conservation Assessment Program (ELCAP) efforts using several warehouses participating in the study for illustration. As the installation sequence for this project comes to a close, final versions of the Measurement Plan Handbook, and Building Characteristic Data Collection Handbook will be published to provide detailed guidance with respect to the collection of utility load research data. Insofar as others planning related metering studies adopt the protocols established for ELCAP, the results of the efforts should be inter-comparable. This desire for compatibility extends to more detailed studies as well as those of more limited scope, as it is hoped that the structured approaches can be applied so other efforts can be placed in context and the results applied for mutual benefit.

25025 (DOE/CE/27460—T6, pp 9.189-9.202) **Hourly load impacts of residential weatherization.** McDonald, C.; Warwick, M. (Synergic Resources Corp., Bala Cynwyd, PA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

This paper describes the analysis of actual hourly load savings from the installation of selected conservation measures including heat pumps, insulation, and storm windows. The study analyzed hourly load data for 119 homes over a three year period; two years prior to retrofit and one year after retrofit. The data set consists of hourly load data before and after weatherization, as well as data for a control group of homes. The data were weather normalized to control for the year to year changes in weather, then load curves were developed for the experimental groups and the control groups. The hourly savings were computed from the differences in the load curves for the experimental and control groups. Extensive diagnostics were evaluated to assess the effect of the weather normalization procedure on the estimates of the hourly load savings. Cluster analysis was used to identify customer segments. The customer segments exhibited distinct differences in load patterns and patterns of savings. Several types of plots were developed to facilitate evaluation and interpretation of the results. The results are summarized in graphs that show load shapes before and after weatherization, the hourly savings and the confidence interval for these savings estimates. 3 references, 8 figures, 1 table.

25026 (DOE/CE/27460—T6, pp 9.203-9.205) **Comparison of end use estimation methods for commercial buildings.** Michaels, H.G. (XENERGY Inc., Burlington, MA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

The methods used to estimate end use in commercial buildings differ in measurement purpose, accuracy, and cost. This summary defines the issues in the comparison and presents conclusions from examination of data. Actual data were presented at the conference. The source file contains detailed engineering information from 5000 commercial building energy audits, with corresponding monthly electric demand and consumption in all cases. In a fraction of these facilities (approximately 50), hourly metering data was also available.

25027 (DOE/CE/27460—T6, pp 9.206-9.219) **Integrated load and time of day models for electricity in residences.** Parti, M.; Sebald, A.; Chaudhury, I.B. (Applied Econometrics Inc.). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

This paper applies Thermodynamic Behavioral Integration (TBI) modeling to electricity consumption in the residential sector in the Nevada Power area. TBI uses conditional demand techniques to integrate thermodynamic and behavioral models. A crucial aspect of the integrated model is explicit incorporation of feedbacks between the engineering and economic components. Overall price and income elasticities are computed including the perverse price effect. This technique has been applied to modeling residential electric consumption, commercial electric consumption, and industrial gas consumption with excellent results. Using TBI, the authors generate a single model incorporating both monthly and time of day consumption for space heating, space cooling, water heating, pool pumping and unspecified. The data set included whole house consumption at both the hourly and monthly levels, as well as end use metering for space cooling and some other end uses. The goal was to use TBI to exploit all levels of data in calibrating a model for both monthly and time of day consumption. The process involves mixing the end use metering data with the whole house data, as well as mixing the monthly and hourly data. Results are given at both the hourly and monthly levels for consumption by each end use. 7 references, 7 figures, 2 tables.

25028 (DOE/CE/27460—T6, pp 9.220-9.238) **Issues in load shape representation.** Pearson, E.W.; Palmiter, L. (Pacific Northwest Lab., Richland, WA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

Large volumes of high time resolution electrical end-use load data are becoming available. In raw time series form such data are cumbersome to manipulate and difficult to interpret. Thus, it is necessary to develop compact representations for such data. To be widely useful, these representations must incorporate dependence on independent variables which strongly influence load. In addition, they should provide useful visual display of the loads and be readily employed in computational work. One approach to construction of useful representations is the generation of simple empirical models for the load date. This paper investigates two techniques for generating such representations: (1) two-way analysis to develop a model of hourly total and refrigeration load data taken from a single residence and (2) empirical orthogonal function techniques to represent electrical consumption in a Seattle office building. The advantages and limitations of the resulting models are discussed. 3 references, 10 figures, 5 tables.

25029 (DOE/CE/27460—T6, pp 9.239-9.261) **Steady state models for analysis of commercial building energy data.** Rabl, A.; Norford, L.; Spadaro, J. (Princeton Univ., NJ). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

This paper examines the suitability of simple steady state methods to analyze energy consumption data of commercial buildings. A steady state analysis can yield information on weather correction, variation of energy consumption with thermostat setpoint and the ratio of heat loss coefficient and heating efficiency. A recently developed procedure, called PRISM, has been very successful when applied to residential buildings. By contrast to residential buildings, the energy consumption of commercial buildings is dominated by equipment rather than the building shell; hence weather correction may be relatively unimportant. If the baseload varies independently of the weather, and the variation is large compared to the heating load, PRISM can give misleading results. Most commercial buildings use forced ventilation by central fans, and the heat loss coefficient changes sharply (by as much as a factor of two) as the ventilation rate is changed between occupied and unoccupied periods. This feature affects the interpretation of the heat loss coefficient that can be extracted by a steady state analysis. In fact, the determination of the heat loss coefficient may be impossible without data on supply rates of fresh air. These features are illustrated with data for several individual office buildings as well as an aggregate of buildings. The relation between thermostat setpoints and space conditioning cost is derived. 23 references, 7 figures, 2 tables.

25030 (DOE/CE/27460—T6, pp 9.262-9.273) **Definition and calculation of a normalized building envelope thermal load.** Robinson, D.A. (Robinson Technical Services). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

Using a simple linear load line to model the increase in envelope thermal load that occurs with decreasing ambient temperature, the slope and intercept of this load line are found by using a least squares technique to fit the total metered energy thermalized within the envelope to the ambient temperature for each measurement period for which the average ambient temperature is below the balance temperature of the house. Analysis of metered data show that the intercept may be below or above the setpoint temperature indicating that additional sources and sinks of energy are present within the house envelope. For this study the parameters required for determining the normalized thermal load were obtained by applying the Princeton Scorekeeping Method (PRISM) to metered data for each house. Calculation of the standard errors for the normalized thermal loads found using this method, plus an examination of the method using heating season data only, indicated that this application of the PRISM program was reliable for the houses examined in the study. Because the proposed method divides envelope losses into ambient temperature dependent and ambient temperature independent components, a more detailed thermal load signature emerges. Samples results are presented to illustrate the effects that solar apertures and varying below grade losses have on the total thermal energy required by a building envelope. 5 references, 1 figure, 1 table.

25031 (DOE/CE/27460—T6, pp 9.274-9.285) **Predicting energy use - influence of the recording interval.** Sharp, T.R. (Oak Ridge National Lab., TN). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155. Contract AC05-84OR21400.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

This paper discusses a study that showed that the recording interval used to record energy use data has considerable influence on the heating energy use rate (slope) and the base temperature resulting from a regression model used to model heating energy use. Fifteen-minute space heating energy use data recorded for four electrically-heated homes in the Minneapolis, Minnesota, area between Jan. 1 and April 30, 1982 were used in the study. The data were aggregated to create the data sets needed to examine the effects of changes in the recording interval on model parameters. An increase in the recording interval increased the slope of the regression model and decreased the predicted base temperature of the building. In predicting annual space heating energy use in a typical meteorological year (TMY), the compensatory changes that occurred in the slope and base temperature were not sufficient to prevent significant differences. The variation was 1-7% for the 4 houses studied. 2 references, 3 figures, 4 tables.

25032 (DOE/CE/27460—T6, pp 9.286-9.287) **End-use approach to building energy analysis using actual lighting energy consumption.** Stoops, J.L.; Gilbride, P. (Pacific Northwest Lab., Richland, WA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155. Contract AC06-76RL01830.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

A graphical presentation of data on end-use energy consumption in commercial buildings uses information collected in the End-Use Load and Conservation Assessment Program (ELCAP) conducted for the Bonneville Power Administration by Battelle, Pacific Northwest Laboratory. The analysis focuses on hourly lighting profiles, and finds that three dimensional profiles of daily hourly lighting consumption across days appears to be almost perfectly smooth for some buildings, which contrasts with the standard assumptions used by building energy simulations.

25033 (DOE/CE/27460—T6, pp 9.288-9.300) **Building as a dynamic calorimeter: determination of heating system efficiency.** Subbarao, K.; Burch, J.; Jeon, H. (Solar Energy Research Institute, Golden, CO). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

Whole building calorimetry is used to determine the efficiency of a residential forced air gas heating system, before and after retrofitting the system. After this calibration, the heating system to the house was turned on and observed for several days. Heating system efficiency is obtained by integrating the heat flows over some interval and dividing by the measured total gas input. This efficiency is the net result of combustion losses as well as distribution system losses to the unconditioned basement. For the furnace tested, initial efficiency was 52 +/- 2%. After the system was retrofitted (mainly increasing the fan flow rate and taping some duct leaks), the efficiency increased to 58 +/- 2%. Building calorimetry has implications far beyond the measurement technique demonstrated in this paper. One related application of interest is on-line diagnosis of HVAC systems, based upon measurements typically available to an energy management system. 12 references, 1 figure, 3 tables.

25034 (DOE/CE/27460—T6, pp 9.301-9.313) **Data acquisition and management systems for the Stockholm project.** Wanggren, B.; Cleary, P. (Royal Institute of Technology, Stockholm, Sweden). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

A major aim of the Stockholm project is the analysis of the energy performance of five new low-energy apartment buildings. Each building is unique, and has its own energy-saving features, including active solar heating, high thermal mass, increased insulation, and seasonal heat storage in bedrock. All the buildings are being extensively monitored for electricity use, air and water temperatures, air and water flows, relative humidity, wind speed, and solar radiation. The sensors were hardwired during building construction. Details of the sensor types used are given. Under control of a micro-computer, sensor readings are taken every five minutes using a multiplexed high precision digital voltmeter, and hourly averages are recorded on computer tape cartridges or floppy disks. Data recorded includes both sensor readings and simple derived value such as energy flows (from a fluid flow and two temperatures). The cartridge or disk is changed every two weeks. The amount of data being gathered in the project is rather large, approximately 10 million data points per year. The data is managed by means of a system called MUMS, written in 1980 to handle large volumes of time sequence data. The system is designed to display the data in both graphical form and tabular. It permits both the production of summary graphs which show the monthly performance of a building at a glance, and the detailed analysis of individual components of the building. The main features of MUMS are described, including examples of typical outputs. 3 references, 3 figures.

25035 (DOE/CE/27460—T6, pp 9.314-9.325) **Use of the Princeton Scorekeeping Method to evaluate gas furnace retrofits in the Denver area: results and limitations.** Warner, J.L.; Claridge, D.E. (Univ. of Colorado, Boulder). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

The Princeton Scorekeeping Method (PRISM) was used to estimate the energy savings resulting from gas furnace tune-ups performed on 69 Denver area residences from 1982-1984. The apparent average savings was 4.9%, but no significant savings can be unambiguously attributed to the furnace tune-ups. Twenty-five cases receiving more extensive tune-ups showed apparent average savings of 7.9%, while 44 cases receiving minor tune-ups showed apparent average savings of 3.1%. Hence the more extensive tune-ups realized appreciable savings by comparison. Examination of tune-ups by season of retrofit and comparison to solar radiation availability changes did not exposure greater savings than those indicated above. A prototypical Denver residence was simulated using the DOE2.1B computer program to generate synthetic input for PRISM. Monthly consumption data from several parametric DOE2 runs tested PRISM's sensitivity to changes in thermostat setpoint, solar gain variations, and furnace curve adjustments. The consumption changes predicted by PRISM for these billing data agreed with the DOE2 changes within 0.1%. 6 references, 7 tables.

25036 (DOE/CE/27460—T6, pp 9.326-9.339) **Performance of the Princeton Scorekeeping Method for estimating annual end-use energy shares as measured with metered end-use load data.** Westman, E.D.; Monroe, W.H. (Bonneville Power Administration, Portland, OR). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005155.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Volume 9, proceedings from the panel on performance measurement and analysis.

The Princeton Scorekeeping Method (PRISM) is a widely used technique for evaluating the performance of residential energy conservation programs. Estimated energy savings are computed from PRISM estimates of space heating and baseload energy consumption for pre and post-program periods. The accuracy of estimated conservation savings is therefore dependent on the accuracy with which PRISM estimates space heating and baseload energy use. This paper reports the results of an evaluation of PRISM's performance at estimating space heating and baseload energy consumption in 40 Pacific Northwest residential households located in Albany and Bend, Oregon. Metered end-use data for an entire year, beginning in April 1983, was used to represent utility billing data in regression models of the specification found in PRISM. Regressions were estimated for each of the 40 households using metered total energy data and local NOAA weather station data. The results of these linear regressions were then compared with the metered end-use data for space heating and baseload end uses. Comparisons were made using a variety of statistical measures. Correlation coefficients for percent errors in PRISM end-use estimates and model inputs and parameters were investigated. Regression residuals were analyzed for behavior of error components, and survey-based characteristics data were used to explore for differences in PRISM's performance distinguishable through dwelling, occupant, and geographic characteristics. Finally, a discussion of the implications of these findings was made with respect to the current uses of PRISM for energy conservation assessment and evaluation. 14 references, 4 figures, 3 tables.

25037 (DOE/CE/27460—T7, pp K.3-K.15) **Measuring the impact of utility residential conservation programs: two case studies.** Braithwait, S.D. (Electric Power Research Institute, Palo, Alto, CA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

A crucial step in determining the cost-effectiveness of utility conservation programs is to measure the energy savings that can be directly attributable to the programs. This paper describes the results of a project designed to develop and test methods that utilities can use to estimate net program-induced energy savings (focusing on electricity) from specific utility conservation programs. These methods focus on the energy-related actions households are likely to take, both in the presence and absence of utility conservation programs. Econometric models of consumer choice to participate in audit and incentive programs, take conservation actions, and consume electricity were estimated using two sets of utility-specific data - for Portland General Electric Company and General Public Utilities. The integrated set of models is then employed to demonstrate their use in resolving program evaluation issues such as separating naturally occurring and program-induced conservation, and self-selection bias. One set of findings indicates that the energy savings directly attributable to a particular weatherization audit and incentive loan program amounted to slightly less than half of the total energy savings. Additional benefits of the approach are a quantification of the factors that influence households' choice of program participation and weatherization actions. 3 references, 1 figure, 5 tables.

25038 (DOE/CE/27460—T7, pp K.16-K.29) **Issues in energy end-use survey research.** Buller, S.M.; Canter, R.J.; Guliasi, L.; Swanson, D.A.; Wong, R.M. (Pacific Gas and Electric Co., San Francisco, CA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

This paper addresses both theoretical and practical problems encountered in commercial sector energy end-use survey research, and offers solutions to some of the problems discussed by drawing on Pacific Gas and Electric Company's experience in this field. The topics discussed include: (1) the diversity of business types and the heterogeneity of energy-using technologies found in the commercial sector, (2) the choice and definition of a unit of analysis; (3) the unique problems associated with using a utility company's billing file for a survey sampling frame, (4) the choice of an appropriate sampling design, and (5) issues concerning data analysis and data reliability. 10 references.

25039 (DOE/CE/27460—T7, pp K.30-K.44) **Conservation resource planning - a tool for linking utility conservation programs, load forecasting, and resource acquisitions.** Gordon, F.M. (Bonneville Power Administration, Portland, OR). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

The Bonneville Power Administration (BPA) has developed a corporate planning and modeling system for selecting the least-cost mix of conservation and generating resources to meet the long-range need for electric power in the Pacific Northwest. This paper briefly reviews the overall modeling system, and then discusses in some detail the planning process and program mix model used to translate the conservation resource acquisition targets that come from the corporate models into 2-year budgets and 20-year plans for acquisition of conservation from specific programs. The overall corporate modeling system and the conservation planning process feature an explicit method for handling uncertainty about future load growth, and, hence, about the need for resources to meet load. The planning system also provides for a careful integration of the knowledge and experience of conservation experts and program managers within and outside of BPA with the powerful analytic capabilities of computer models. Among the technical and modeling issues discussed in this paper are: (1) dealing with uncertainty about resource needs; (2) modeling consumer-initiated versus utility-subsidized conservation activity; (3) incentive/penetration relationships. 3 figures.

25040 (DOE/CE/27460—T7, pp K.45-K.56) **Integral role of conservation program evaluation in the Bonneville Power Administration.** Keating, K.M. (Bonneville Power Administration, Portland, OR). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

Too often program evaluation is added as an afterthought in conservation programs. In such cases the opportunity to prepare for important evaluation needs is lost during the design of the program. In addition, the resources and attention devoted to the program evaluation reflect the importance and usefulness evaluation holds within the organization. Since the establishment of the evaluation function in Bonneville Power Administration's (BPA) Office of Conservation, the design of all programs and pilots includes evaluation from the earliest stages. Required early consideration provides the opportunity for a methodologically sound evaluation design. It is also constructive for program designers, because it helps assure them that the questions they seek to answer can be addressed with the pilot. This paper explains the high priority and extensive resources given to program evaluation in BPA by detailing the roles that evaluation plays in the organization. Among these roles are: measuring savings, measuring the levelized costs of the savings, providing input to the supply curve, providing input to the load forecast, influencing program design, and recommending modifications to ongoing programs. 5 references.

25041 (DOE/CE/27460—T7, pp K.57-K.66) **Evaluation of one warm room: an experimental program designed to determine the effect of a portable electrical heater on KWH consumption in homes with central electric heating.** Ridge, R.S. (Southern California Edison Co., Rosemead). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

In 1983, the Southern California Edison Company conducted an experimental program which placed a $60 1500-watt portable electric heater into each of 140 households in a retirement community in Los Angeles. The question addressed by this evaluation was whether the use of a single portable electric heater could significantly reduce electricity consumption in homes with central electric heat. A pretest-post-test control-group design was used to investigate this question. Heaters were distributed to those in the treatment group on January 19. Beginning on April 20, data were collected from both those in the treatment and control groups using telephone interviews. Data included attitudes and behaviors related to household energy conservation and demographic characteristics. In addition, for both groups, kWh data for the period January 15 - April 15 for both 1982 and 1983 were obtained from computerized customer billing files. Analysis of covariance was used to analyze these data using average monthly kWh consumption for the 1982 period and square footage of the home as covariates. The results indicate that the treatment group had an average monthly kWh consumption for the 1983 period that was 107 kWh lower than the control group. This difference is of both a statistical and practical significance. 3 figures.

25042 (DOE/CE/27460—T7, pp K.67-K.82) **Effect of burning wood on savings electricity: an exploratory analysis.** Stram, D.O.; Socolow, R.H.; Fels, M.F. (Princeton Univ., NJ). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

The Princeton scorekeeping method is applied to a conservation data base from the Northwest to determine the impact of wood use on the resulting estimates of saved energy as well as on conservation behavior is explored. Significant findings are that houses using wood have more erratic heating demands, and hence somewhat less well-determined model parameter estimates, than do those houses without large amounts of supplemental wood usage. This effect, however, is relatively mild, involving mainly an increase in outliers, and does not seem to require a radical change in the scorekeeping procedure. The reliability of Normalized Annual Consumption, in particular, as a conservation index is affirmed. The large difference in electricity conservation between houses in the data base using supplemental wood for heating and those not using it is striking. The results suggest that respondent-estimated wood usage may be more significant as an indicator of a propensity to conserve than a true reflection of the magnitude of a switch to a replacement fuel for electricity. With good scorekeeping tools, this interesting hypothesis can be tested on other data sets. The findings to date indicate that the same scorekeeping methodology being developed for electrically heated houses not using supplement fuel can be used on wood-burning houses as well. 4 references, 3 figures, 6 tables.

25043 (DOE/CE/27460—T7, pp K.83-K.90) **Evaluation of TVA's solar information service and recommendations for future programs.** Vories, R. (Infinite Energy, Denver, CO). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

The Tennessee Valley Authority evaluated the effectiveness of activities of the Education Section of the Solar Applications Branch from March to May of 1983, then made recommendations for revising and adding activities. The author saw the development of basic assumptions about several aspects of the solar marketplace as a key element of the evaluation, with the main underlying assumption that TVA's information programs would be more effective if they were based on a marketing approach to reaching consumers rather than an educational approach.

25044 (DOE/CE/27460—T7, pp K.91-K.103) **Survey contributions to program evaluations.** Windell, P.A. (Bonneville Power Administration, Portland, OR). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

Traditional program evaluations classically involve the use of experimental or quasi-experimental designs. Due to the costs associated with the collection of data, a simultaneous survey designed to serve additional purposes may serve both as a benchmark and a control group source pool. The 1983 Pacific Northwest Residential Energy Survey (PNWRES) was designed to explicitly account for the needs of the evaluation of BPA's residential weatherization program. This paper briefly describes this strategy and how it was implemented. The paper also describes plans for future coordination. 2 references, 2 figures.

25045 (DOE/CE/27460—T7, pp K.104-K.114) **Planning for evaluation: a method developed for the North Carolina alternative energy corporation.** Wirtshafter, R.M.; Sorrentino, A.; Veigel, J.M. (Univ. of Pennsylvania, Philadelphia). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

The University of Pennsylvania and the North Carolina Alternative Energy Corporation (AEC) have developed a project evaluation handbook that encourages formalization of a broader notion of the evaluation process. Designed as a self-help planning tool, the handbook addresses the critical issues of goal definition, determination of success criteria, and isolation of key project components. By working through the increasingly detailed handbook questions, the project evaluator both gains a clear sense of the project's organization and direction and comes to recognize project elements that waste time and money. The first section of the paper describes both the evaluation needs of the AEC and the scope of the method, including the perceived benefits of this kind of approach. The second section reports on the application of the approach for the AEC's Local Government Energy Officer project. In conclusion, the paper gives a critical assessment of the strengths and weaknesses of the method. 2 references, 1 figure.

25046 (DOE/CE/27460—T7, pp K.115-K.126) **Solar technical information program (STIP): a model for conservation technology transfer.** Berberich, C.W.; Potter, T.F. (Solar Energy Research Institute, Golden, CO). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

This paper describes processes now in use by DOE's Solar Technical Information Program (STIP) to address the technical information requirements of interested parties and discusses considerations for potential application to buildings conservation technologies. STIP researchers, develops, and produces Technical Communication Publications reflecting developments in solar research; announces their availability to targeted technical audiences from a file of 40,000 scientists, technologist, and other professionals in solar technologies; facilitates their distribution in the most cost effective manner; and operates a Technical Inquiry Service, staffed by solar professionals, to provide answers to technical questions concerning solar technology R & D. By writing specifically to communicate results, rather than to record research methods and results, STIP has established a second level of technical publication that is more apt to be read and digested by a broad spectrum of readers. Coordination with research entities and private sector interests has led to coverage of solar R & D efforts which deserve wider exposure than that provided by conventional research report dissemination. Parallels between solar and conservation user needs are drawn and the conclusion supported that a Conservation Technical Information Program would be beneficial. 1 figure.

25047 (DOE/CE/27460—T7, pp K.127-K.139) **Engineering education in energy conservation and HVAC design.** Claridge, D.E.; Ball, D.; Dow, J.O. (Univ. of Colorado, Boulder). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

Evidence suggests that many HVAC/Energy engineers receive much (if not most) of their HVAC/Energy training after college. A survey of Denver area ASHRAE members found that 60% have ME degrees, 23% have other engineering degrees, and 17%

do not have an engineering degree. Those with engineering degrees have typically taken 3 or 4 courses in theoretical and applied thermal sciences - or have spent about two-thirds of a semester in studying of topics directly relevant to HVAC/Energy engineering. Those without engineering training typically had no courses directly relevant to the area. Examination of college catalogs for 182 ME programs showed that 26% offer no courses, 48% offer one or two courses and only 26% offer more than two courses dealing with HVAC, conservation and/or solar. The nine Architectural Engineering programs offer an average of 3.6 courses in these area. Eighteen universities were identified which offer a total of five or more courses (the equivalent of one semester or more of full time study in these areas). Recommendations based on these findings are to (1) make a comprehensive survey to determine employers' perceptions of the need for increased HVAC/Energy engineering training; (2) provide more information to the industry about the programs; and (3) initiate steps to strengthen existing programs or establish new programs as warranted. 4 references, 8 tables.

25048 (DOE/CE/27460—T7, pp K.140-K.150) **Assessing research and development needs from a building industry perspective.** Eichenberger, M.A. (American Institute of Architects Foundation, Washington, DC). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

This paper describes a process to solicit building energy research needs as identified by major building industry organizations, such as The American Consulting Engineers Council (ACEC), the American Institute of Architects (AIA), American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) to name a few. Preliminary findings suggest building industry organizations are able to identify research needs which reflect the problems faced by their members when they incorporate energy efficient technologies into buildings. The research needs reflected the roles and professional responsibilities of the particular association. Almost every research need contained a systems integration and analysis component and performance monitoring. Every research need contained a technology transfer product and mechanism. They ranged from technical articles, workshops, special publications and guidelines to algorithms and computer-aided design and analysis tools. Several of the research needs mentioned the importance of integrating energy information into existing information sources, such as the ASHRAE Handbook of Fundamentals, Architectural Graphic Standards and Time Saver Standards. The results can be used to plan building energy programs because the needs came from organizations whose memberships have first-hand familiarity with building energy problems. It appears that using a needs-based approach could lead to a more user-oriented research program, i.e. one that meets the needs of building industry practitioners and product component manufacturers. 3 tables.

25049 (DOE/CE/27460—T7, pp K.151-K.167) **Carmel Valley Workshop: developing a national building energy research Agenda.** Frankel, E. Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

An overview of the Building Energy Research workshop emphasizes the effort to formulate a national agenda for research in energy efficiency and solar energy related to buildings. The need for such an effort came from the administration's decision to discontinue funding for this type of research. The participants represented industry, universities, and public interest groups. The plans of the workshop were later crippled by DOE's procurement requirements, but positive results came from the dialogue and exchanges of ideas. 6 figures.

25050 (DOE/CE/27460—T7, pp K.168-K.174) **National program planning: philosophy and example.** Lundy, T.S. (Oak Ridge National Lab., TN). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005144. Contract AC05-84OR21400.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume K, Proceedings from the panels on improving methods of program evaluation: special topics.

Numerous examples of national program planning may be cited. All are linked to purpose and philosophy of their development and have various schemes for implementation. In the energy area, they vary from an abortive weekend assignment to a former presidential aide to much more successful endeavors. All are intended to be guiding lights for future actions to assist in solving national energy problems. This paper will share background information, philosophy of approach, and current status for planning of national scope which concentrates on research needed to improve energy efficiencies of the thermal envelopes of their national stock of buildings. This specific effort, initiated during 1977, has resulted in two major national planning documents with a third now conceived. 5 references, 2 figures, 1 table.

25051 (DOE/CE/27460—T10, pp L.3-L.15) **Guidelines for the public sector: implementing a third-party financed energy services transaction.** Breed, D.P.; Michaelson, M.L. (Lane and Edson, P.C., Washington, DC). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

This paper provides an orderly approach to identifying and selecting among the many options available to a public entity in selecting an energy service company. The paper begins by describing the factors a public entity will want to consider in making the initial decision whether to pursue third-party financing for energy efficiency projects. Each of the following sections of the Paper describes the steps involved in soliciting and selecting an energy service company including: (1) selecting and initiating the procurement process, (2) establishing parameters for development, (3) designing selection criteria, (4) preparing the solicitation document, (5) evaluating proposals, and (6) negotiations. Many developers can meet exacting technical specifications, or offer attractive contract terms to the public entity. Experience has shown, however, that it is the ability of the energy service company to deliver the proposed financing in a timely fashion that is crucial to the success of the transaction - and that is too often overlooked in the course of the selection process.

25052 (DOE/CE/27460—T10, pp L.16-L.27) **Performance contracting in New York City-owned multi-family buildings.** Brennan, M.A.; Zelinski, R.W. (New York City Community Preservation Corp., NY). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

Part I of this paper deals specifically with performance contracting as an innovative source of capital for energy efficiency improvements in government-owned buildings by presenting a case study of a New York city energy services contract for a group of City-owned apartment buildings. The New York City contract is the first privately-funded energy services contract for residential buildings owned by a municipality. The second part addresses the transferability of the lessons learned in the New York City experience to other government entities and to non-profit institutions through the use of a computer program, developed by Public Technology Inc., which evaluates shared savings against other forms of available financing. It is assumed that the reader has a basic understanding of the legal and financial structure of a performance contracting agreement. Many of the factors which make shared savings difficult to implement for government entities are equally applicable to residential properties. Since the New York city contract implements energy services in small, scattered-site apartment buildings owned by the City, many of the points covered below will also apply to privately owned multi-family buildings.

25053 (DOE/CE/27460—T10, pp L.28-L.40) **Canertech Conservation Inc. (Canercon).** Brett, J.T. (Canertech Conservation Inc., Ottawa, Ontario). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

Canertech Conservation Inc. (Canercon) is a subsidiary of Canertech Inc., a crown corporation of the Government of Canada, and was established in 1980 as a venture capital company in energy conservation and renewable energy technology. Canercon addressed the building retrofit market on the grounds that there was a large untapped market for turnkey retrofit projects in all types of buildings. The one-stop approach for both implementation and financing of the project was intended as a catalyst to private firms to enter the energy retrofit market. The author describes the services, financing, and history of the Canercon study and activities.

25054 (DOE/CE/27460—T10, pp L.41-L.49) **Utility of ESCO: two viewpoints.** Esteves, R.M. (Sentinel Energy of Minnesota, Inc.). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

This report briefly examines why and under what conditions conservation is desirable for the utility company and why it should seek to provide conservation services. It looks at the various types of utility support normally available, both financial and non-financial, with special emphasis on the shared savings/energy service company concept. The shared savings approach solves a significant number of problems for the utility, financing being only the most obvious. The report examines this development from the viewpoint of a proponent in looking at the benefits both to the utility and to society and examines it from the opponent's viewpoint, looking at the actual or potential harm to the utility company and to society. Finally, it briefly examines the way a few utilities have approached the opportunity to minimize the potential problems while securing some of the advantages for themselves and their customers.

25055 (DOE/CE/27460—T10, pp L.50-L.64) **Financing alternatives for energy management retrofits.** Fenster, L. (Natkin Energy Management, Englewood, CO). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

A facility owner has numerous funding options for an energy management program, including the traditional methods of cash, debt, or lease. In addition, the relatively new and non-traditional method of shared savings, a Performance Contracting concept, properly applied, can offer higher cash flows, a higher IRR, and substantially less risk to the owner for an energy management program. Thus, an owner should carefully evaluate not only the technical and simple economic considerations of an energy management program, but should also carefully evaluate the alternative sources of capital funding for the program to insure the optimal financial results in the future. 1 figure, 6 tables.

25056 (DOE/CE/27460—T10, pp L.65-L.77) **Municipal solar utilities: the promise and the reality.** Hamrin, J. (Jan Hamrin Associates, Sacramento, CA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

The pendulum has shifted away from heavily government financed energy programs towards public/private sector joint ventures in the energy area. For the most part, these types of programs involve the use of private sector capital with the public sector providing publicity, legitimacy, protection against abuse, some marketing and other types of services. One such program begun in the early 1980's was the Municipal Solar Utility (MSU) program, first developed in the City of Oceanside to stimulate the leasing of solar water heating systems for multi-family residences. Three communities have implemented this and at one point forty more were considering this option. However, changes in the tax law and the development of other types of private sector programs will change the form and possibly even the viability of future MSU leasing programs. This paper reports on the present status of MSU solar leasing programs and the future potential for this new innovative institution both in the area of solar water heating and other technology applications. 1 table.

25057 (DOE/CE/27460—T10, pp L.78-L.87) **Energy management in the commercial sector: the marketing role of financing.** Hobbs, C.D.; Arthur, D.L.; White, J.K. (Portland General Electric Co., OR). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

The author discusses the marketing role of financing, in contrast to its economic role, in energy management services for the commercial sector. A survey of commercial businesses indicates that acceptance is due to a low awareness level and skepticism of vendors among decision makers, the low priority of energy cost reduction relative to business expansion, a lack of capital for conservation investments, and a judgment that such investments are not cost-effective. Four generic market segments are those which are financially strong and debt averse and those which show a debt preference, those which are financially constrained, and institutional. Subsidies must be packaged to reflect these differences.

25058 (DOE/CE/27460—T10, pp L.88-L.100) **Issues and challenges for third party financing: an agenda for the next ten years.** Klepper, M. (Lane and Edson, P.C., Washington, DC). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

Third-party energy financing is now a full fledged industry. It has successfully passed through the early stages of product birth and market testing, and now appears as an important, if not critical, factor in the energy efficiency industry. There are now more than 100 firms that will finance and install energy conservation measures on a performance contracting basis. Over 2000 buildings have had energy measures installed under an energy services agreement. The author identifies ten critical issues that will face the third-party financing industry during the next ten years. After describing each issue, he suggests a variety of steps that can - and perhaps will - be taken within the next ten years to deal with each of these issues. A compilation of these suggested steps constitute an agenda for the future of the energy services industry.

25059 (DOE/CE/27460—T10, pp L.101-L.112) **Penny saved is half a penny earned: Pennsylvania's third party (share savings) financing program for energy conservation.** Shinn, R.A.; Rametta, J. (Governor's Energy Council, Harrisburg, PA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

This paper describes the practical experience gained by the State of Pennsylvania in developing and implementing a third party financing program for energy conservation, coal conversion, and cogeneration in public buildings operated by state government. It reviews the origins of Pennsylvania's program and the process of energy management and budgeting in state buildings. It describes the procedures, criteria, evaluation, and results of ranking state facilities as potential candidates for a pilot program in shared savings. It identifies the key features of the program's contractor selection process and the kinds of issues and questions that were raised in a bidder's briefings with third party financing firms. The paper concludes with a list of lessons learned for state and local governments or others who are just beginning a third party, shared savings program of energy conservation.

25060 (DOE/CE/27460—T10, pp L.113-L.126) **Emerging role of the public sector in third-party finance.** Weedall, M. (Bonneville Power Administration, Portland, OR). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

Regardless of the availability of Federal and State tax incentives, public sector use of third-party finance will continue and is likely to grow. The reason is that there are significant potential earnings for the third-party industry in the public sector marketplace. Older building stocks and the pressing need of the public sector to reduce energy bills create an attractive investment opportunity. It is almost a captive market. The need for energy efficiency is so great in the public sector as more activity develops, energy service companies will be hard-pressed to meet the demand for services. Of course, the number of public bodies which can benefit from third-party finance will diminish greatly without Federal tax incentives. The tradeoff between enhanced revenues and reduced energy efficiency must be understood as the Federal government considers changes to the tax structure.

25061 (DOE/CE/27460—T10, pp L.127-L.137) **Perspective on the history of third-party financing of conservation in the United States.** Weisenmiller, R.B. (Independent Power Corp., Oakland, CA). Aug 1984. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005145.

In ACEEE (American Council for an Energy-Efficient Economy) 1984 summer study on energy efficiency in buildings: Doing better: Setting an agenda for the second decade: Volume L, Proceedings from the panel on financing conservation: energy management services, shared savings, and other mechanisms.

The past four years have been a period of explosive growth for third-party financing of conservation. Some energy has been saved and some money has been made. It has been necessary to establish energy service companies as accepted and reputable ways of doing business. As with any infant industry these first few steps were slow and tottering. Now the industry is entering its adolescent phase. Its future is bright. The surface has just been scratched in terms of energy savings and business opportunities.

25062 (DOE/CE/27460—T12, pp 6.7-6.11) **Lighting code compliance training through the use of interactive video tapes.** Baker, W.S. (Oregon State Univ., Corvallis). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

Lighting codes are a cost effective and logical approach to reducing commercial energy and power requirements, and encourage the use of daylight. However, codes are only as good as their enforcement, and training plays a key role in enforcement. Training code officials through the use of a technical reference manual that is coupled with a video tape is an innovative and cost effective way of providing the training. The technical reference manual can also assist those who have to submit plans and specifications for code compliance. Continuing education and professional development to non-university students is an often overlooked area in efforts to reduce energy consumption.

25063 (DOE/CE/27460—T12, pp 6.12-6.24) **Model conservation standards - lessons learned from the perspective of designing and managing building code enforcement programs.** Crossman, P.L. (Bonneville Power Administration, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

A review of the Northwest region's experience and progress towards implementing mandatory energy-efficiency standards also discusses the institutional lessons that were learned in the process. The author follows a three-year period of Bonneville Power Administration's development and operation of building code support programs and other technical assistance activities designed to encourage voluntary adoption and enforcement of the standards. He also assesses program refinements, describes efforts to integrate building energy-efficiency requirements into existing code enforcement networks, appraises the need for sensitivity to local political and economic circumstances, and describes the progress made and future challenges. 1 reference.

25064 (DOE/CE/27460—T12, pp 6.25-6.38) **Analysis of minimum efficiency standards and rebate incentive programs for domestic refrigerators in the Pacific Northwest.** Geller, H.; Scanlon, T. (American Council for an Energy-Efficient Economy, Washington, DC). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

This paper examines the energy savings potential and cost-effectiveness of stimulating higher levels of refrigerator efficiency in the Pacific Northwest through minimum efficiency standards and rebate incentive programs. It is estimated that refrigerator efficiency standards could save 27-32 MW (avg) by 1995 in the region. Rebate programs offered by BPA could save 5-7 MW (avg) by the same year. There is much greater savings potential with standards because they would apply to the entire region as opposed to the service territory available to BPA for conservation programs, and because standards affect all product sales while rebate programs have a limited response. Furthermore, refrigerator standards are much easier to implement and administer in comparison to rebate programs, they are cost-effective for consumers in the Northwest, and they require virtually no expenditure on the part of utilities or states. If minimum efficiency standards are adopted, it may still be worthwhile to offer rebates as an incentive for the purchase of high-efficient models. 13 references, 2 figures, 3 tables.

25065 (DOE/CE/27460—T12, pp 6.39-6.51) **Searching for an implementation strategy for the model conservation standards: a utility perspective.** Hammarlund, J. (Public Power Council, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

The Northwest Power Planning Council (Council) has made conservation the cornerstone of its regional power plan and the regionwide adoption of model conservation standards (MCS) to substantially increase the energy efficiency of new buildings the focal point of its conservation efforts. By emphasizing the adoption of building codes, the goal was for the entire region to be building to the MCS performance standard by 1986. However, with the region still experiencing an energy surplus, progress has been much slower than expected. The Council recently adopted a new MCS implementation strategy that emphasizes BPA and utility marketing and incentive programs, and rejects much of the guidance offered by BPA and most of the region's utilities. Early indications suggest widespread utility opposition to the new approach. This paper chronicles the interplay between the Council, BPA, and the utilities as they searched in vain for a mutually acceptable MCS implementation strategy. Secondary attention is given to other important actors such as the state and local governments, builders associations, and the environmental community. It concludes with a mildly positive assessment of the future prospects for MCS. 1 figure.

25066 (DOE/CE/27460—T12, pp 6.52-6.54) **Overview of California's appliance efficiency programs.** Messenger, M. (California Energy Commission, Sacramento). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

California Energy Commission's programs have effected the efficiency level of appliances sold in California and the distribution of these sales over efficiency categories. These Efficiency Standards programs have saved billions of dollars for California's consumers. However, it is not enough to count on the adoption of standards to increase the market sales of higher efficiency appliances. Utility incentive programs, consumer information programs, and R & D expenditures have and should be used to create a market pull for high efficiency products. The CEC's development of a consumer slide ruler is but the first of many steps toward achieving higher efficiency products and lower energy costs. 2 figures, 1 table.

25067 (DOE/CE/27460—T12, pp 6.55-6.65) **Model conservation standards - lessons learned in providing technical support to the building code industry.** Rowan, S.S. (Bonneville Power Administration, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

The Bonneville Power Administration has supported the implementation of the Model Conservation Standards by providing technical support to building code officials and the code development industry. Two main lessons have been learned: (1) Take the time, up front, to understand existing infrastructures. Only to learn of their existence is not enough. To understand is to acquire the ability to relate to the history, rationale, purpose and methodology of change of the infrastructure. To understand is to develop a respect for the existing code development industry. (2) Use this understanding in designing support programs that are consistent with the existing infrastructure, and creatively add to, strengthen and complement it. This includes assisting the building code industry in counteracting and overcoming any pitfalls discovered. Specific examples of mistakes made and subsequent lessons learned when working with building code officials and the code development industry are presented.

25068 (DOE/CE/27460—T12, pp 6.66-6.67) **Innovative approach to mandatory residential energy standards.** Sackett, J.G.; Bollinger, D. (City of St. Louis Energy Management Program, MO). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

The St. Louis Energy Management Program has worked on demonstration projects with homebuilders and developers for three years. A conservative approach prevailed in developing energy savings standards acceptable to homebuilders. A computer model with standard heat loss, air-conditioning options, and costs for each of seven construction components carried out the economic analysis for the standards. The program developed discrete steps in energy improvements and associated costs for each component: walls, ceiling, floor, windows, air-infiltration, heating equipment, and cooling equipment. The mandatory standards reduced heating and cooling costs by 20-25%. A superinsulation package will target a 50% reduction over conventional energy costs.

25069 (DOE/CE/27460—T12, pp 6.68-6.79) **New building energy standards for UCSD: institutional barriers, current impacts and future pitfalls.** Sebald, A.V.; Gordon, A.S.; Nichols, J.A.; Myking, E.S. (Univ. of California, San Diego). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

An energy standard for new buildings was developed in 1984 by the campus energy committee and approved by all administrators at UCSD. The standard now applies to all new campus buildings regardless of funding source. The standard deals with all aspects of energy consumption in new buildings including building layout, allowable spaces for air conditioning, building equipment efficiency, zone separation, and building HVAC control systems. It specifies mandatory consumption metering in all new buildings. It also enhances habitability. This paper surveys energy standards for other universities. It compares the UCSD energy design situation before and after implementation of the standard (including a detailed description of energy provisions in the standard). The process by which the standard is imbedded in the actual design/construction process is described. The paper discusses the financial and institutional barriers to energy efficient design in university buildings and to implementation of a standard. It discusses the predicted effects of the new standard in Engineering I (the only completed design to date) and lists the other new buildings to which it has already been applied. 2 references.

25070 (DOE/CE/27460—T12, pp 6.80-6.81) **Overcoming market resistance to energy conservation in rental housing: reaching owners of tenant-metered buildings.** Strom, S.; Nathanson, I. (Minneapolis Energy Office, MN). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

Minneapolis used a carrot and stick strategy to persuade local landlords to install tenant-metered units that involved a package of financial incentives and a mandatory rental energy standard. The carrot side also includes contracting services to perform weatherization and other energy improvements. A system of grants and low-interest loans were available to participating building owners to make the improvements.

25071 (DOE/CE/27460—T12, pp 6.82-6.99) **Virtual space heating loads and energy conservation: lessons from the northwest.** Watson, R.K. (Natural Resources Defense Council, San Francisco, CA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005152.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 6, Proceedings from the panel on mandatory measures.

Much of the uncertainty in Pacific Northwest energy demand forecasts lies in residential electric space heating, with lifestyle changes having affected demand reductions more than improvements in the building stock. The concept of the virtual space heating load (VHL) as the upper bound of demand assumes full-home heating to 65 degrees and no secondary fuel use. The study uses the Northwest Power Planning Council's 1983 engineering model estimates as the VHL proxy for pre-1980 buildings and engineering calculations from the model for new buildings. A recent utility estimate provides the lower bound of consumption. Using the High Case scenario, the author reduces uncertainty by about 375 aMW over a 10-year planning period. Reduced uncertainty adds up to $960 in value to each Model Conservation Code and weatherized house, although this value may be too high. 1 figure, 2 tables.

25072 (DOE/CE/27460—T18, pp 1.5-1.17) **Residential earth-coupled and groundwater heat pump demonstrations and follow up technology transfer.** Allhusen, G.D. (New York State Energy Research and Development Authority, Albany). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

Monitored data from a field demonstration of state-of-the-art residential earth-coupled heat pump systems in Upstate New York indicates that properly used, installed, and maintained packaged liquid-to-air units with any water heating option will achieve a seasonal performance factor range of 2.5 to 3.0. A primary advantage of ground-source heat pumps over other heating systems is their ability to efficiently produce hot water and thermal comfort throughout the year. Following a concurrent study of groundwater heat pumps, a technology transfer project disseminated the results. 9 figures.

25073 (DOE/CE/27460—T18, pp 1.18-1.30) **Realistic approach to high efficiency gas water- and space-heating.** Bosma, G.J. (Mor-Flo Industries, Inc., Cleveland, OH). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

When consumers became more conscious of increasing utility costs they looked at a furnace or boiler energy upgrade, but overlooked their reliable, but inefficient gas water heater. The Federal Trade Commission water heater labeling program and better training of sales personnel has gradually educated consumers to compare life-time with initial costs and understand the advantages of integrated appliances. The integrated appliance uses the excess capacity of a gas water heater to simultaneously provide space heating in a variety of combinations. The author describes the efficiency advantages of several combination units, and outlines the keys to successful marketing of integrated appliances. 3 figures.

25074 (DOE/CE/27460—T18, pp 1.31-1.43) **Residential natural gas furnace performance study.** Brunt, J.; Carlson, S. (Madison Energy Conservation Committee, WI). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

The technology involved in the design and manufacture of residential gas furnaces has significantly changed in recent years. The many different models, brands and types of furnace units have prompted a study of the impact of these changes. This paper discusses both the energy use changes realized when new furnace units have been installed, and the problems that owners who recently installed new furnaces have reported. The study compares energy use changes in 72 households in the City of Madison that had new furnaces installed in the year 1983. The methodology used to analyze the energy savings normalizes the natural gas consumption so as to separate energy use data into weather related and nonweather related components. This paper also discusses changes in the households' electric consumption related to the installation of the new furnace unit and compares changes in total energy usage with the difference in size of the new furnace to the old furnace. 2 references, 8 figures, 4 tables.

25075 (DOE/CE/27460—T18, pp 1.44-1.46) **Ventilating an energy efficient house using an air-to-water heat pump.** Eckman, T. (Northwest Power Planning Council, Portland, OR). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

Throughout North America the most frequent technological solution employed to ensure adequate ventilation in new air tight residences has been the use of ducted, air-to-air heat exchangers (AAHX). An alternative heat recovery ventilation (HRV) system for providing fresh air while recovering heat from stale exhaust air employs an air-to-water heat pump. This paper provides a brief overview of the design installation and typical operation of a US made, air-to-water heat pump ventilation and heat recovery system (HPHRV). 1 figure.

25076 (DOE/CE/27460—T18, pp 1.47-1.61) **DHW energy savings in multifamily buildings.** Englander, S.L.; Dutt, G.S. (Princeton Univ., NJ). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

Field studies and energy consumption analyses of domestic hot water (DHW) system retrofits at seven multifamily buildings complexes in Trenton and Asbury Park, New Jersey all involved substitution of separate gas-fired water heating equipment for existing systems, all of which used central space-heating boilers to heat the water. Only one of the new systems consists of water heaters in each apartment; the rest are centrally based. The measurement of energy savings from these retrofits posed special problems which precluded the direct use of a standard scorekeeping methodology such as PRISM (The PRInceton Scorekeeping Method). Some of the problems were: oil-heated buildings where tanks are not filled during deliveries, oil to gas equipment conversion, lack of DHW fuel submetering, concurrent heating system retrofits, seasonal changes in DHW heating equipment, and changes in gas meter configuration before and after retrofits. Since some of these situations are quite common, the methodology developed to handle them will have broad applicability. The results show variations in savings across buildings, ranging from -15% to +8% for the five buildings for which annual savings were determined. The three buildings with positive savings also report an inadequate supply of hot water following the retrofit. The lack of savings is a surprising result, since the installation of a water heater separate from the heating system is a popular measure generally believed to have significant energy savings potential. 9 references, 3 figures, 1 table.

25077 (DOE/CE/27460—T18, pp 1.62-1.75) **Evolution of ventilating heat pump water heater.** Gehring, K.C. (DEC International Inc., Madison, WI). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

Therma-stor Products Groups have developed products which incorporate water heating, ventilation, space heating, and space cooling in a single efficient unit. The products include a heat pump water heater developed for dairy refrigeration and two styles of systems developed for houses: a simple one direction air flow system that exhausts with winter exhaust and summer intake and a semi-balanced air flow system for ultra tight homes or those with open vented combustion systems. Common features of the systems are that they (1) recover heat from exhaust air streams to reduce water and space heating costs, (2) deliver cool dry ventilation in the cooling season, (3) reduce water heating cost, (4) provide consistent ventilation, and (5) provide basement dehumidification if needed. The author describes the development, marketing, and control strategies of the products. 7 references, 3 figures, 4 tables.

25078 (DOE/CE/27460—T18, pp 1.76-1.89) **Energy efficient appliances: 1986 update.** Geller, H. (American Council for an Energy-Efficient Economy, Washington, DC). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

This paper reviews the latest developments in energy efficient refrigerators, gas furnaces, water heaters, air conditioners, cooking equipment, and clothes dryers. Both newly commercialized and prototype technologies are covered, including new energy-efficient refrigerators built in Europe and the US, advanced heat pump and gas-fired water heaters, gas-fired space heating equipment, air conditioners, heat pump and microwave clothes dryers, and advanced gas stove burners. The performance, energy savings potential, cost-effectiveness, and status of these technologies are examined. Marketing issues are also discussed. 34 references, 2 tables.

25079 (DOE/CE/27460—T18, pp 1.90-1.103) **Monitored hot water use: a seasonal analysis.** Gladhart, P.M.; Weihl, J.S. (Michigan State Univ., East Lansing). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

A multivariate extension of Kempton's 1984 analysis of residential hot water use as behaviorally driven uses a more complete data set of the same Michigan houses of the earlier study. The authors disaggregate hot water demand into discrete hot water use events, which they measure for time of occurrence, duration, volume, and place of demand. The nine families show substantial variation in the relative frequency of different end uses from season to season. With energy requirements for water heating a major concern of utility planners, these findings suggest that substantial variation of volumes results from habits or preferences of water consumers. Whether behavior can respond to educational or policy measures is unknown, but the behavioral aspects of demand are valuable inputs into utility planning. 5 references, 1 figure, 5 tables.

25080 (DOE/CE/27460—T18, pp 1.104-1.122) **High efficiency heating system at Haverstick Homes, Trenton, NJ.** Gold, C.S. Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

A case study of 122 public housing units in Trenton, New Jersey with a central boiler and underground hot water piping system for space and water heating found a fuel reduction of 50% after installation of the system for the 14 buildings. The project involved the selection of replacement boilers, analyses of piping requirements, and condensate disposal. The retrofit is suitable for properties with large, functionally obsolete, central boilers hot water systems. Conclusions from the study are that (1) condensing boiler systems should employ series hot water converters, (2) better piping materials and methods are desirable, (3) building operators need to improve maintenance management procedures, and (4) hybrid systems are more cost-effective and have a wider applicability.

25081 (DOE/CE/27460—T18, pp 1.123-1.139) **Developing cost curves for conserved energy in new refrigerators and freezers.** Goldstein, D.B.; Miller, P. (Natural Resources Defense Council, San Francisco, CA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

Energy consumption in refrigerators can be reduced through the application of a number of conservation measures. These measures may be introduced in many different combinations and in varying orders, each of which will result in a different cost of conserved energy. A microcomputer model is constructed which estimates the impact of specified conservation measures on energy consumption and on initial and life cycle costs. The model is used to develop cost curves with measures ranked in order of increasing marginal cost. Cost curves are developed for three models of refrigerator/freezers and two freezers. They show potential savings of more than 75% of current energy use at costs that compare favorably with current electricity prices. This paper begins with a brief description of the model's structure and the calculational algorithms. Next, the cost curves - with measures applied in order of increasing marginal cost - are derived. Measures are described along with their associated incremental first costs, marginal costs of saved energy, and net life cycle cost savings. 1 figure, 5 tables.

25082 (DOE/CE/27460—T18, pp 1.140-1.154) **Converting steam heated buildings to hot water: practices, savings and other benefits.** Loebenstein, M.S.; Hewett, M.J.; Dunsworth, T.S. (Minneapolis Energy Center, MN). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

The conversion of steam heating systems in older buildings to hot water heating systems was investigated to determine how common conversions are in Minneapolis, what modifications are typical, how much it costs, and how much energy is saved. The study is based on interviews, site visits and PRISM analysis of monthly gas data. In all the conversions studied, the boiler was replaced. Other work done depended on the building's existing system. In two pipe steam (TPS) systems, the existing distribution system was retained. In single pipe steam (SPS) systems new piping and radiation was installed, and other changes were made to allow the buildings to be zoned. These changes make SPS systems more expensive and difficult to convert. As a result, SPS buildings are converted less often, even though SPS systems are much more common than TPS systems in Minneapolis. The final sample was ten buildings, four SPS conversions, and six TPS conversions. They include seven multifamily buildings, one commercial building, on church rectory, and one duplex. The SPS buildings showed savings of 13% to 27% of total weather normalized gas use and the TPS buildings had savings of 17% to 39%. Other benefits helping to make conversion attractive include more even heating, fewer tenant complaints, reduced maintenance, and increased building values. 10 references, 3 figures, 3 tables.

25083 (DOE/CE/27460—T18, pp 1.155-1.169) **Experience with air-to-air heat exchangers in the residential standards demonstration program in Washington state.** Lubliner, M.; Kingrey, W.; Byers, R. (Washington State Energy Office, Olympia). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

The Residential Standards Demonstration Program introduced a major new housing construction technology to participating builders and homeowners in the form of the air-to-air heat exchanger (AAHX). This paper summarizes the experience of the authors in the design, installation, cost, operation, and performance of AAHX systems. Specific problems encountered by both builders and occupants are described and analyzed. Recommendations for manufacturers, installers, builders and code officials are presented. 11 references, 9 figures, 2 tables.

25084 (DOE/CE/27460—T18, pp 170-182) **Residential water heating energy conservation alternatives.** Perlman, M. (Ontario Hydro Research Div., Toronto). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

An overview of potential energy conservation techniques for improving the operating efficiency of conventional domestic water heating installations summarizes current water heating trends and alternatives in the potential energy savings matrix. Available data show that standard conservation techniques have relatively limited potential for energy savings, but they are technically feasible, inexpensive, and easily retrofitted by homeowners. They could also be attractive to utilities on large-scale energy and load management programs. Laboratory and field experiments indicate that new water heating technologies are very efficient, and that recovery and delivery capability of the systems is satisfactory. Despite a higher initial cost, the benefits associated with energy savings, space cooling, humidity control, and indoor air quality may justify the cost. 16 references, 7 figures, 1 table.

25085 (DOE/CE/27460—T18, pp 1.183-1.196) **Multi-family pilot project: single pipe steam balancing hot water outdoor reset.** Peterson, G. (Minneapolis Energy Office, MN). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

The Multi-family Pilot Project (MFPP) to test a delivery mechanism and to refine the technology for conservation retrofits in single pipe steam (SPS) and multizone hot water (MZHW) apartment buildings found that the major cause of energy waste in SPS buildings is uneven heating. The temperature is usually set to satisfy the coolest apartment which overheats other apartments and wastes energy. Balancing strategies include controlling the boiler cycle, installing main line and radiator air vents, conducting a tenant survey to identify remaining problems, and using thermostatic air vents and other techniques to fine-tune the system. In 25 installations, energy savings averaged 9.3%, the average cost was about $1400, and the median simple payback was 1.4 years. Field and laboratory tests were conducted on main line and radiator air vents which showed significant differences in venting rates and the importance of these differences in achieving even heating. The most cost effective retrofit for MZHW apartment building is the outdoor reset of boiler water temperature. The MFPP tested a delivery mechanism for the retrofit on 18 buildings, where energy savings averaged 9.1%, the average cost was $615, and the median simple payback was 1.9 years. A computer simulation found that as much as 50% of the potential savings can be lost with the use of the wrong reset ratio. 7 references, 11 figures.

25086 (DOE/CE/27460—T18, pp 1.197-1.202) **Advanced insulation for appliances.** Potter, T.F.; Christensen, C.B. (Solar Energy Research Institute, Golden, CO). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

This paper describes the energy-saving potential of using superior insulation in appliance walls, focusing on reducing energy use in refrigerators. The paper also describes a vacuum insulation concept now under development at the Solar Energy Research Institute (SERI). The heat transfer through the refrigerator shell is discussed and compared to other energy-using components. Alternative methods to reduce conductive and radiative heat transfer are described, including vacuum insulation, which is discussed with incremental strategies. Finally, costs and major balance-of-system modifications possible with superior insulation are briefly discussed, as well as efficiency contributions by other innovative components, such as desiccants and thermoelectric heat pumps that would be possible if shell losses were greatly reduced. 7 references, 2 figures.

25087 (DOE/CE/27460—T18, pp 1.203-1.219) **Low cost furnace efficiency program - 10,000 furnaces later.** Proctor, J.; Foster, B. (Sun Power Consumer Association, Littleton, CO). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

Over 10,000 furnaces have been treated by agencies under the Colorado low cost furnace efficiency program. The results from three new studies of this program are reported in the paper. The first is Solar Energy Research Institute (SERI) sponsored research on over 800 furnaces, including a PRISM analysis of three sets of furnaces and the effect of changes in non-linear systems on PRISM analysis. The second is extensive monitoring of a single new home before and after furnace modification, which shows a potential savings of 11.3%. The third investigation, done by the State of Colorado on the latest program shows a savings of about 12%. This new information makes possible a screening method to guarantee that the program works on the highest priority furnaces. There is a detailed analysis of the individual items contributing to the savings and areas requiring additional research. This success is a result of substantially more than the use of specific technical options. The training, feedback, inspection, monitoring, and administration are essential and radically different from most weatherization programs. These facits of the program, which are largely responsible for it's success, would require substantial revision in weatherization programs. 3 figures, 7 tables.

25088 (DOE/CE/27460—T18, pp 1.220-1.237) **Dual fuel heating in North Carolina.** Sigmon, T.; Phelps, T.; Ferrell, G. (Research Triangle Institute, Research Triangle Park, NC). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 1, Proceedings from the panel on appliances and equipment.

Dual fuel heating systems usually use electricity as their primary energy source, but switch to a back-up fuel during times of peak electrical demand. Since these systems can be arranged to use primarily off-peak electricity which is much less expensive for electric utilities to provide, substantial savings on electricity cost can be passed on to the homeowner who uses dual fuel heating. In early 1984 the North Carolina Electric Membership Corporation (NCEMC) and the N.C. Alternative Energy Corporation undertook a study and field test of three types of dual fuel heating systems for use in residential applications. The purposes are to evaluate both consumer and electric utility economics of dual fuel heating systems in the North Carolina climate, and to gain practical experience operating these systems under direct utility load control. To date, an analytical study of dual fuel systems has been completed and the performance of eight systems installed in single-family residences has been monitored for one heating season. Performance testing of these systems will continue into 1986. Results to date indicate that the economics of dual fuel systems are most dependent on the cost of off-peak electrical power, total heating season energy requirements, and the means of controlling use of the standby fuel. It also appears that substantial discounts on the cost of electricity (in the range of 30 to 40%) can be offered to dual fuel system users and justified by the electric utility. 3 references, 4 figures, 6 tables.

25089 (DOE/CE/27460—T18, pp 1.238-1.250) **Domestic hot water consumption in four low-income apartment buildings.** Vine, E.; Diamond, R.; Szydlowski, R. (Lawrence Berkeley Lab., CA). Aug 1986. ACEEE, 1001 Connecticut Ave., NW, Suite 535, Washington, DC 20036. File Number TI87005147. Contract AC03-76SF00098.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings:

Volume 1, Proceedings from the panel on appliances and equipment.

Domestic hot water consumption is a major source of energy use in multifamily buildings. In contrast to space heating energy consumption, in which behavioral factors compete with the effect of climate, domestic hot water consumption is highly dependent on behavior. Knowledge of usage patterns is useful in understanding domestic hot water consumption, whether for calculating baseline usage or for estimating retrofit performance. The authors monitored domestic hot water consumption in four apartment buildings (a total of 48 units) managed by the San Francisco Public Housing Authority for six months, and interviewed the residents about their hot water usage patterns. They found the shape of the measured profiles of daily domestic hot water consumption to be different from profiles published in the literature. A model of household water consumption based on reported behavior found occupant-reported water consuming behavior to correspond well with measured data: building differences ranged from -19% (the model underpredicts) to 12% (the model overpredicts), and the average difference was approximately 12%. Educational status was the only significant sociodemographic predictor of estimated household hot water consumption. 8 references, 4 figures, 4 tables.

25090 (DOE/CE/27460—T23, pp 8.118-8.133) **Low income weatherization program: toward establishing program objectives ten years later.** Hubinger, G. (Minnesota Dept. of Energy and Economic Development, St. Paul). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

Federal and state governments have funded programs to weatherize the homes of low income people since the middle 70's, primarily through the federal Weatherization Assistance Program. Minnesota has invested some $30 million of its own appropriations combined with approximately $68 million in federal funds to weatherize almost 100,000 residences around the state. One apparent - but extremely critical - deficiency has been the lack of clearly established objectives for the program. Is the Weatherization Program's goal to reduce the fuel bills for low income people and if so, to what degree? Is it to eliminate or at least significantly reduce reliance on fuel assistance? Is it to invest public funds to a point of positive net present value? Or is it to achieve some common standard of efficiency for all buildings that are improved? Is it to improve as many residences as possible at a more limited level so at least some benefits accrue to all low income households? Or should the focus be on fewer homes improved to ensure greater quality? Or is Federal Weatherization a jobs training program for providing disadvantaged individuals with skills that are marketable? This paper begins a discussion of these fundamental questions that lead to very different outcomes in the way the program is administered and in the results that are achieved. After reviewing other studies that propose objectives for the Weatherization Program, another alternative is suggested which takes into account the future reliance of the household on Energy Assistance. This alternative policy indicates that a substantially larger investment, almost 7 times the current level, could be justified in order to obviate the need for any future Energy Assistance payments. Under this scenario, up to $11,600 could be cost effectively invested in Weatherization if significant energy savings - exceeding 50-60% - were achievable.

25091 (DOE/CE/27460—T23, pp 8.161-8.174) **Validation of the LBL Residential Energy Model.** McMahon, J.E. (Lawrence Berkeley Lab., CA). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

The US Department of Energy (DOE) has used the LBL Residential Energy Model since 1979 to estimate the national impacts of federal minimum efficiency standards for residential appliances (including space conditioning equipment) on consumers' energy consumption and costs. The LBL model combines engineering (appliance costs and efficiencies) and economics (demand elasticities for fuel and efficiency choice, and usage) to simulate future energy consumption by end-use. This paper examines the three forecasts using the model (published in 1980, 1982, and 1983) to quantify, in hindsight, their accuracy. The forecasted variables examined are: efficiency of new appliances and volume of shipments. In many areas, data and methodology changes improved the forecasts. Some problem areas remain. The error of forecasts is composed of inaccuracy in exogenous variables (e.g., expected oil price, or economic growth) and the failure of the model methodology to capture the actual responses to those (or other) variables. After removing the error due to erroneous forecasts of driving variables, a backcast is performed from 1978-1984, using a new methodology for forecasting equipment efficiencies. They calculate the short-term model accuracy in replicating underlying components of residential energy consumption in the USA. 14 references, 3 figures, 2 tables.

25092 (DOE/CE/27460—T23, pp 8.224-8.236) **Improving energy efficiency in Chinese housing.** Wirtshafter, R.M.; Sorrentino, A.; Song-ying, C. (Univ. of Pennsylvania, Philadelphia). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

In China, even though climatic conditions are severe, energy use in buildings has traditionally been very insignificant by Western standards. As a result, the Chinese have little experience with the use of energy conservation, passive solar energy or central heating. The recent increases in household energy consumption have left two options: increase household energy use at the expense of industrial and environmental gains or develop policies to conserve or restrict household energy consumption. This paper records one such effort to introduce low-cost energy conservation practices in Henan Province, China. The paper describes both the practical problems encountered in the introduction of new building materials and designs, and also the institutional barriers that inhibit the development of an energy conservation delivery system. A major theme of this paper is show unsuitable Western solutions are for solving energy conservation problems in developing nations. For instance, the high cost and unavailability of materials requires building redesign solutions that do not utilize insulation, vapor barriers, and modern heating and cooling plants. Similarly, the coordination of worker units and government officials in developing countries for a wide-scale conservation program is vastly different from either the public or private development programs in the developed world. 20 references, 6 figures.

25093 **(DOE/CE/63481—T4) Report on the business development project of the South Middlesex Opportunity Council.** (South Middlesex Opportunity Council, Framingham, MA (USA)). 15 Jan 1987. Contract FG01-86CE63481. 31p. NTIS MF A01; 2; GPO Dep. File Number DE87007113.

The Department of Energy awarded the South Middlesex Opportunity Council (SMOC) a planning grant to enable SMOC and a consortium of community based organizations known as the Community Energy Partnership (CEP) to explore their future business opportunities and expand their energy activities. The original members of CEP had preexisting federal and state Weatherization Assistance Program grants and had joined together in July, 1985 to provide energy audits and related arranging services for residential consumers as contractors to three eastern Massachusetts utilities under the aegis of the Residential Conservation Service (RCS). SMOC and the other community-based organization which comprised CEP formulated four goals which guided their planning activities under the DOE grant: (1) to expand the scope of the existing energy program activities carried on by member agencies; (2) to add more community based organizations to their membership, eventually achieving a statewide service capability; (3) to diversify their funding base; and (4) to provide a wider variety of energy conservation services to low and moderate income households.

25094 (DOE/CE/64846—T1) Achieving the conservation advantage: Monograph 2, An executive briefing: Final. (Blue Cross and Blue Shield Association, Chicago, IL (USA)). 20 Feb 1986. Contract FG01-84CE64846. 28p. NTIS, PC A03. File Number DE87007567.

In August 1984, the Department of Energy (DOE) awarded the Blue Cross and Blue Shield Association a 20 month grant to prepare and distribute a series of publications on hospital energy conservation. The first executive briefing in the series, The Conservation Advantage, was published in December 1985. Written expressly for hospital administrators, it highlights the merits of energy conservation as a component of an overall cost-containment strategy. Achieving the Conservation Advantage is the second publication in the DOE sponsored series. Progressing from discussion of hospital energy conservation addressed in the first publication, this briefing addresses the mechanics of energy management particularly through energy services companies. Achieving the Conservation Advantage provides straightforward answers to typical questions posed by hospital executives when considering energy efficiency improvements. The question and answer segment is followed by a list of negotiating tips for energy services contracting, a reference section on energy management through energy services companies, and a list of energy services companies interested in working with hospitals.

25095 (DOE/NBM—7007410) City of Corvallis Rental Housing Energy Conservation: Final report. Christensen, J.J. (Corvallis Community Development Dept., OR (USA)). Jun 1986. 56p. NTIS, PC A04. File Number DE87007410.

This report provides a summary of the results of the Corvallis Rental Housing Energy Conservation Project. In addition to the report summary of the BPA project marketing and educational activities, Appendices A, B and C contain background material regarding the Corvallis weatherization financing program. For individuals reviewing the project results, these appendices are recommended reading for understanding Corvallis innovative approach to promoting rental housing energy conservation.

25096 (DOE/NBM—7007411) Electric Energy Conservation and Production project: [Volume 2]. (Blackfeet Indian Tribe, Browning, MT (USA); Black Hawk Associates, Denver, CO (USA)). Feb 1984. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007411.

A final report has been prepared under the Electric Energy Conservation and Production Project, conducted by the Blackfeet Indian Tribe and its consultants, Black Hawk Associates, Inc. The report addresses two major issues - the heavy reliance on electricity by residents of the Blackfeet Reservation, and the opportunities for electricity production from wind energy resources on the Reservation. The findings of this report help provide a basis for comprehensive energy management planning on the Reservation, analyze the potential for minimizing electricity demand and maximizing the efficiency of electrical end-uses through appropriate conservation measures, assess the potential of wind energy resources located on the Reservation, and identify and assess the technical, financial, legal, institutional, and regulatory issues involved in wind energy development within the Blackfeet Reservation.

25097 (ECRC/M—2083) Case for heat pump ventilation heat recovery. McIntyre, D.A. (Electricity Council Research Centre, Capenhurst (UK)). Nov 1986. 14p. Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK.

Full house mechanical ventilation with heat recovery (VHR) has already been shown in practice to provide both a reduction in house heating costs and improved internal air quality. It is possible to upgrade a VHR system by the addition of a small air-to-air heat pump, which extracts heat from the exhaust air and delivers it to the supply air. This provides additional heat input to the house at low cost; the cost of heat provided is normally less than half that of low rate electricity. The maximum size of the heat pump, and hence the maximum heat input, is limited by the required ventilation rate of the house. Hence it is not possible to provide all the house heat requirement with this system. However, the heat pump VHR system can provide over half the seasonal heating requirement.

25098 (ECRC/M—2107) Householders' use of storage heaters. Crawshaw, C.M.; Williams, D.I.; Steele, L.M. (Electricity Council Research Centre, Capenhurst (UK)). Nov 1986. 76p. Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK.

An investigation into the understanding and use of storage heater controls was carried out. The general level of satisfaction with storage heating was high (90%) and most people had a reasonable idea of how the system works, what the controls do and of the tariff costs. However, the study did find substantial areas of ignorance; 37% could not say what controls their heater had and 15% did not know what tariff they were on. This lack of knowledge may prevent users getting the best performance from their heating system, resulting in discomfort and large bills.

25099 (ECRC/M—2108) Engineering aspects of legionnaires disease. Brundrett, G.W. (Electricity Council Research Centre, Capenhurst (UK)). Nov 1986. 11p. Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK.

There are four factors which influence the risk of Legionnaires Disease:- 1) The bacteria are so widespread that they should always be assumed to be present. Their multiplication can be prevented by avoiding the use of lukewarm water and also by biocidal water treatment. 2) The contaminated water is harmless until it is dispersed. To minimise dispersal as an aerosol, drift eliminators should be incorporated in cooling towers. 3) Infection cannot start until the very fine contaminated aerosol is inhaled. Cooling towers should therefore be located well away from windows or air inlets and people should be kept away from aerosol generators. 4) Susceptibility to Legionnaires Disease varies and certain groups of people such as the elderly require special care.

25100 (ED—92/138) Automatic lighting control with personnel input facility. Final report. (Department of Energy, London (UK). Energy Efficiency Office; Building Research Establishment, Watford (UK); UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Avon Cosmetics Ltd., Northampton (UK)). Oct 1986. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751845.

Avon Cosmetics Ltd. has installed an automatic lighting control system in the packaging hall of their Northampton factory. For a total investment cost of Pound 16,777, net savings of Pound 7,800/year have been achieved leading to a simple payback period of just over two years. The Switchplan control system installed allows control of the packaging hall luminaires by automatic timeswitches with extensive capability for overriding the timeswitch controls using manual switches located near the individual work stations. The project has demonstrated that it is possible for a retrofit installation of automatic lighting controls to yield substantial savings in industrial premises with a high lighting load and where the premises are subject to variable occupancy patterns.

25101 (EPRI-EM—5113-Vol.2) Hydronic heat pumps for residential and light-commercial applications: Volume 2, Appendixes: Final report. Fischer, D.; Ball, D.; Talbert, S.; Broehl, J.; Buhr, A.; Martineau, T. (Battelle Columbus Labs., OH (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 233p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920326.

The technical and economic potential of hydronic heat pump heating systems was investigated. The work included review of the status of current hydronic and hydronic heat pump technology in the US and Europe, development of candidate design concepts and performance parameters for air-to-water, water-to-water and backup systems, development of control strategies to minimize costs and electrical demand, analysis of transient and seasonal performance for a wide range of applications, and preliminary investigation of the financial attractiveness and market potential of hydronic heat pump systems. The status review uncovered only a few suppliers of hydronic heat pumps in the United States. Hydronic heat pumps in Europe are technologically mature, but the market expansion is impeded by high initial and installation costs. Steady-state and transient performance of a candidate hydronic heat pump was computed using available models adapted for the hydronic application. Design and application features explored included refrigerant type, source temperature, convector sizing, compressor type, condenser and evaporator sizing, optimum charge, frosting/defrosting losses, control strategy, effect of day and night rates, thermostat setback and electrical demand, and thermal energy storage. Based on life-cycle cost savings, a number of hydronic heat-pump systems appear financially attractive in selective applications. Consumer awareness and education are considered essential to market growth.

25102 **(LBL—21187) Electricity and the home: An international overview of trends.** Schipper, L.; Ketoff, A.; Meyers, S.; Hawk, D. (Lawrence Berkeley Lab., CA (USA)). Sep 1986. Contract AC03-76SF00098. 66p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007907.

This report describes historical trends in residential electricity use and the forces underlying those trends in 11 industrialized countries, including the United States. It focuses on the period since 1973. It discusses the causes for the changes in electricity demand growth since 1973 in each of the main end-use markets for electricity, and discusses the reasons for the differences among the countries. Some issues of importance for understanding the future direction of residential electricity use in the industrial countries are discussed.

25103 **(LBL—21578) Residential heating and cooling energy cost implications associated with window type.** Sullivan, R.; Selkowitz, S. (Lawrence Berkeley Lab., CA (USA)). Nov 1986. Contract AC03-76SF00098. 19p. (CONF-870101—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007602.

From American Society of Heating, Refrigerating, and Air-Conditioning Engineers meeting; New York, NY, USA (18 Jan 1987).

A comparative study is presented in which residential heating and cooling energy costs are analyzed as a function of window glazing type, with a particular emphasis on the performance of windows having low-emittance coatings. The DOE-2.1B energy analysis simulation program was used to generate a data base of the heating and cooling energy requirements of a prototypical single-family ranch-style house. Algebraic expressions derived by multiple regression techniques permitted a direct comparison of those parameters that characterize window performance: orientation, size, conductance, and solar transmission properties. These equations are used to discuss the energy implications of conventional double- and triple-pane window designs and newer designs in which number and type of substrate, low-emittance coating type and location and gas fill are varied. Results are presented for the heating-dominated climate of Madison, WI, and cooling-dominated locations of Lake Charles, LA, and Phoenix, AZ. The analysis shows the potential for substantial savings but suggests that both heating and cooling energy should be examined when evaluating the performance of different fenestration systems. Coating and substrate properties and the location of the coating in the glazing system are shown to have moderate effects as a function of orientation and climate. In addition, with the low-conductance glazing units, the window frame becomes a contributor to overall residential energy efficiency.

25104 **(LBL—22281) Field study of exhaust fans for mitigating indoor air quality problems: Final report.** Grimsrud, D.T.; Szydlowski, R.F.; Turk, B.H. (Lawrence Berkeley Lab., CA (USA)). Sep 1986. Contract AC03-76SF00098. 104p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007900.

Residential ventilation in the United States housing stock is provided primarily by infiltration, the natural leakage of outdoor air into a building through cracks and holes in the building shell. Since ventilation is the dominant mechanism for control of indoor pollutant concentrations, low infiltration rates caused fluctuation in weather conditions may lead to high indoor pollutant concentrations. Supplemental mechanical ventilation can be used to eliminate these periods of low infiltration. This study examined effects of small continuously-operating exhaust fan on pollutant concentrations and energy use in residences.

25105 **(LBL—22510) The residential standards demonstration program: Matched pair cost analysis.** Vine, E. (Lawrence Berkeley Lab., CA (USA)). Dec 1986. Contract AC03-76SF00098. 126p. NTIS MF A01; 2; GPO Dep. File Number DE87007886.

The Pacific Northwest is currently experiencing a dramatic and exciting transformation in the way the region produces and consumes energy. Prompted by federal legislation and local initiative, the region is promoting the conservation of energy as the primary new energy resource. In the residential sector, energy efficiency standards for new electrically heated construction have been proposed, and a demonstration program is underway to examine the costs and energy savings associated with building houses to levels of higher energy efficiency. This report examines the energy-efficient construction costs, reported by builders in this program, of a select group of recently built "matched pair" houses (these were two otherwise identical houses except that one was built to "super" energy-efficient standards while the other one was built to current energy codes).

25106 **(LBL—22872) Implementation of home energy rating systems.** Vine, E.; Barnes, B.K.; Ritschard, R. (Lawrence Berkeley Lab., CA (USA)). Feb 1987. Contract AC03-76SF00098. 101p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007898.

This paper presents the findings of a national survey of home energy rating and labelling programs (HERS). We discuss the nature of different implementation problems and the kinds of strategies that have been used to deal with them to ensure the effective penetration of HERS to all HERS-users. Of further special interest to us has been the nature of different delivery systems. We examined 34 HERS, located in 28 states: 13 of these were located in the southeast, 8 in the midwest, 5 in the northeast, 4 in the Pacific/mountain region, and 3 in the southwest. Although our survey does not represent a scientific sampling of HERS, we believe that the final distribution accurately reflects the distribution of HERS through the country and the full range of likely implementation and delivery programs.

25107 **(NP—7751718) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.3: Some basic remarks on the probable development of demand for heat for space heating, commercial and industrial applications. Subsection A.3.1. Changes in heating habits and heating methods.** Winkens, H.P. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). 1982. 36p. (In German). NTIS (US Sales Only), PC A03. File Number DE87751718.

In the framework of investigations for methods of meeting energy demand by sources other than heating oil in the Rhine and Neckar region, the development of the requirement of space, useful and process heat is in principle commented on, including special hints given regarding changes in heating habits and heating methods. General statements are made as to the development of end-use energy consumption by private households and small consumers, future consumption developments are evaluated, and the economic efficiency of thermal insulation measures is pointed out. This includes the results of studies and cost savings achieved with heating systems by thermal insulation measures. Conclusions are drawn as to the presumable transmission heat requirement for the year 2000. An addendum informs on the optimization of thermal protection measures and thermal protection cost in settlement types of old buildings and of new buildings. (HWJ).

25108 **(NP—7751719) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.2: Load conditions for a satisfied heat demand. Subsection A.2.1. Fundamentals for determining the heat requirements for space and water heating.** Kalkum, B.; Haeubi, F. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). May 1981. 155p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751719.

This contribution to the investigation of ways and means of meeting energy demand from sources other than fuel oil presents the load conditions for a satisfied heat demand as well as the bases for establishing that heat demand for space and water heating. It describes the house as an energetic system and the function of heating/ventilation/air-conditioning systems in the heat balance as well as calculation and dimensioning bases. Explanations deal furthermore with the determination of space heat requirements by pointing out demands on in-house climate (comfort, air hygiene), anthropogenic heat production and external climate. Heat losses are indicated; so are solar heat gain and the heating system's automatic control capability. Establishment and significance of hot water requirement are dealt with. Differences as compared to the standard heat requirement and to the actual maximum load are pointed out, and the determination of the annual heat requirement of a building is described as well as the time characteristics of heat demand. Finally calculation methods (collection of formulas) for transmission and ventilation heat requirement as well as for water heating and new buildings are given and maximum performances and annual heat requirement pointed out. (HWJ).

25109 (NP—7751721) **Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.4. Energy transfer and heating centers in residential buildings, heating systems.** Klosa, F. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). Nov 1982. 347p. (In German). NTIS (US Sales Only), PC A15/MF A01. File Number DE87751721.

This two-part contribution to investigations regarding possible substitutes for the energy source heating oil in the Rhine and Neckar region first of all gives a comparative analysis of the use of gas, electricity and district heat based on new investigations, studies, and publications. Starting from the grouping of heat generation systems according to the categories single-room, flat, central and district heating systems (service connection types, cost of the transmission station), the report deals with the later installation of a central heating system and its service connection to the district heat line (boiler, high-efficiency boiler) as well as with energy storage at the site of consumption and the heat pump system. Subsequently selected cyclic processes and modes of operation are explained (compression, absorption) and heat pumps for heating purposes, energy boxes and solar systems presented. The second part of the report is concerned with energy transmission and central heating stations in buildings as well as with heating systems. Figures are provided regarding the cost of different types of heating, including heat pump, solar plant with oil-fired boiler and solar absorber. (HWJ).

25110 (NP—7751734, pp 1-33) **Thermal insulation measures; relating measures of improvement to settlement structures.** Pape, G. 1981. (In German). NTIS (US Sales Only), PC A06. File Number DE87751734.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.3: Some basic remarks on the probable development of demand for space heating, commercial and industrial applications. Subsection A.3.2. Energy conservation by thermal insulation measures in buildings.

As a contribution to investigations regarding ways and means of meeting energy demand by sources other than heating oil in the Rhine and Neckar region, a work sheet on thermal insulation measures and their assignment to different settlement types was prepared. It presents first of all the commonest thermal protection measures for the building shell elements wall, window, roof and floor, as they are available in the Federal German market and applied in building, separately by old and new buildings. This is followed by assignment considerations regarding settlement types ST 2/4/5/6 and mention of systems to improve external walls (thermo sealing, rigid expanded polyurethane plates, reinforced plastics), windows (double glazing, double insulation glazing); roof (insulating felt from mineral fibers), cellar ceiling (particle-foam thermal insulation plates on swinging estrich). (HWJ).

25111 (NP—7751734, pp 1-44) **Cost-optimized thermal insulation according to settlement structures.** Haeubi, F. 1981. (In German). NTIS (US Sales Only), PC A06. File Number DE87751734.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.3: Some basic remarks on the probable development of demand for space heating, commercial and industrial applications. Subsection A.3.2. Energy conservation by thermal insulation measures in buildings.

In the framework of investigations regarding the possibility of meeting energy demand by sources other than heating oil in the Rhine and Neckar region, a very comprehensive collection of tables on the cost and effect of thermal insulation measures in typical old and new buildings of different settlement types is presented. For each typical building technically feasible thermal protection improvements were worked out. The related cost is presented as a function of the extent of thermal insulation. For each typical building an EDP-aided optimization of the improvement in thermal insulation was carried through. An explanation is given for the structure of the heat cost function to enhance understanding of the table 'combination of measures with optimum return' (investments, annual cost, heat requirement, savings). A graphic presentation is given for the dependence of the mean k-value on thermal protection investments. Tables containing the detailed calculation results are presented. (HWJ).

25112 (NP—7751734, pp 1-11) **Optimization of thermal insulation and heat supply under economic aspects. The SIOPT/UR program.** Roth, U. 1981. (In German). NTIS (US Sales Only), PC A06. File Number DE87751734.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.3: Some basic remarks on the probable development of demand for space heating, commercial and industrial applications. Subsection A.3.2. Energy conservation by thermal insulation measures in buildings.

In the framework of investigations regarding the possibility of supplying energy sources other than heating oil in the Rhine and Neckar region, a memorandum on the operational optimization of thermal protection and heat supply (computer program SIOPT/UR) is presented. It is proven that this is a problem of operational optimization where constructional measures for thermal protection must be clearly differentiated from the linking of these measures optimized in themselves, to heating systems. Optimum solutions in thermal protection are achieved if a combination of different measures is adopted. The publication explains in how far the maximization of 'return' in thermal protection is paramount. This includes whole external walls, openings, flooring or ceiling against cellar and roof. Examples are given for thermal-protection constructions with pertaining cost diagram, and three different categories of cost are indicated that are caused by heat supply systems: capital, operational, and energy cost. Furthermore figures are provided as to the minimization of the total annual cost resulting from thermal protection and heat supply, and inexpensive heating systems and thermal protection measures are pointed out. (HWJ).

25113 (NP—7751734, pp 1-27) **REV/OPT: A tool for heat demand calculation and for economic analysis of thermal insulation measures in large areas.** Haeubi, F.; Langraf, B. 1981. (In German). NTIS (US Sales Only), PC A06. File Number DE87751734.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.3: Some basic remarks on the probable development of demand for space heating, commercial and industrial applications. Subsection A.3.2. Energy conservation by thermal insulation measures in buildings.

In the framework of investigations on ways and means of meeting energy demand by sources other than heating oil in the Rhine and Neckar region, a report is contributed on an instrument for calculating heat requirement and for looking into the economic efficiency of thermal protection measures in larger areas of investigation. First of all, the term 'thermal protection optimization' (interdependence of heat cost and thermal protection cost) is explained. A computer-aided procedure for evaluating redevelopment measures in heating installations is then more closely dealt with. The central problem complexes of the computation procedure include the calculation of thermal output requirement and heat respectively energy requirement, the economically suitable selection or combination of thermal protection measures, and establishment of the expenditure involved and savings, as well as economic efficiency evaluation of improvement measures. On these three complexes, which must be considered in computer-aided optimization, an overview is given that is supported by diagrams. Finally the computer prints obtained (standardized data recording sheets) and some evaluation examples for individual buildings (type of building, thermal protection measures, economic efficiency of existing and new heating systems) are discussed. (HWJ).

25114 **(NP—7751734) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.3: Some basic remarks on the probable development of demand for space heating, commercial and industrial applications. Subsection A.3.2. Energy conservation by thermal insulation measures in buildings.** Roth, U. (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). 1981. 125p. (In German). NTIS (US Sales Only), PC A06. File Number DE87751734.

Subsection A.3.2 'Energy conservation by thermal insulation measures in buildings', of research project ET 5286 A comprises 4 papers: 1) Thermal insulation measures; relating measures of improvement to settlement structures; 2) Cost-optimized thermal insulation according to settlement structures; 3) Optimisation of thermal insulation and heat supply under economic aspects. The SIOPT/UR program; 4) REV/OPT: A tool for heat demand calculation and for economic analysis of thermal insulation measures in large areas. Separate records are available for each of the 4 papers.

25115 **(NYSERDA—87-6) Field evaluation of high-efficiency gas furnaces: Final report.** (Rochester Gas and Electric Corp., NY (USA); RIT Research Corp., Rochester, NY (USA)). Feb 1987. 75p. NYSERDA, Two Rockfeller Plaza, Albany, NY 12223. File Number TI87900582.

This report describes the results of a field test involving an evaluation of six different types of "high-efficiency" furnaces. The sample was selected to represent as many of the new designs as were currently available at the project's outset. The primary objective of this research was to determine the seasonal efficiency for each of these units in a typical installation. Seasonal efficiencies were determined by comparing the performance of each unit to an electrical resistance heater connected in a parallel arrangement. The gas furnace and electric heater were used during alternate weeks. A regression analysis was performed to determine the relationship between weather parameters and the minimum heat requirement of each site based on the energy consumption by the electric heaters. The results of the regression analysis were used to predict the heat energy requirements of each site during the periods the gas furnace was used. The predictions were compared to actual fuel consumption to determine seasonal efficiencies. None of the units operated at its AFUE rating. Generally, the measured steady-state efficiencies were also less than the AFUE rating. It was concluded that the obtainable performance was sensitive to the particular installation. An economic analysis indicated favorable paybacks in two situations; where replacement of a present unit was mandatory and/or in new construction. A survey of government and environmental regulatory agencies revealed no consensus regarding the proper method of condensate disposal.

25116 **(ORNL/CON—213) Heating energy measurements of unoccupied single-family houses with attics containing radiant barriers.** Levins, W.P.; Karnitz, M.A. (Oak Ridge National Lab., TN (USA)). Jan 1987. 89p. NTIS, PC A05/MF A01. File Number DE87007803.

Tests were conducted by Oak Ridge National Laboratory (ORNL) to determine the magnitude of the heating energy savings achieved by installing attic radiant barriers. The radiant barriers used for the test consist of a material with two reflective aluminum surfaces on a kraft paper base. The experiment was conducted in three unoccupied research houses operated by ORNL. Two variations in the installation of radiant barriers were studied. One house was used as the control house (no barrier was installed), while the other two were used to test the two methods for installing the radiant barriers. In one house, the radiant barrier was laid on top of the attic fiberglass batt insulation, and in the other house, the barrier was attached to the underside of the roof trusses. The attics of all three houses were insulated with a kraft-paper-faced R-19 fiberglass batt insulation. The winter test with the radiant barrier showed that the horizontal barrier was able to save space-heating electical energy in both the resistance and heat pump modes amounting to 10.1% and 8.5%, respectively. The roof truss radiant barrier increased consumption by 2.6% in the resistance mode and 4.0% in the heat pump mode. The horizontal orientation of the radiant barrier is the more energy-effective method of installation.

25117 **(ORNL/Sub—79-24712/4) Engineering field evaluation of the Westinghouse/DOE dual-stroke advanced electric heat pump.** Fagen, T.J.; Young, R.R.; Lucheta, R.A.; Veyo, S.E. (Oak Ridge National Lab., TN (USA)). Nov 1986. Contract AC05-84OR21400. 264p. NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE87007804.

A preprototype advanced electric heat pump with a unique dual-stoke compressor was installed in an occupied residence in Jeannette, PA (near Pittsburgh). Analysis of field performance data indicates a heating performance factor (HSPF) of 8.13 Btu/Wh, and a cooling energy efficiency (SEER) of 8.35 Btu/Wh for the year April 1, 1983 through March 31, 1984. For the year April 1, 1984 through March 31, 1985, the indicated heating season performance factor (HSPF) was 8.51 Btu/Wh and the cooling season energy efficiency ratio (SEER) was 7.89 Btu/Wh. During the first heating season the peak electrical demand at temperatures above 42°F was 4.0 kW. At lower temperatures the demand reached a peak of 18.0 kW at -2°F. During the second heating season modifications to the method of controlling resistance heat and lowering of the upper and lower heating balance points reduced the peak demand to 3.8 kW at temperatures above 38°F. Maximum demand at -10°F was 14.6 kW. Peak electrical demand during cooling operation ranged from 2.1 to 4.6 kW during the first cooling season and 2.2 to 4.2 kW during the second cooling season. The heat pump was considerably oversized for the test house since the observed lower balance point was 8°F whereas 17°F was optimum. Analysis indicates that if properly sized, the system could deliver an HSPF = 8.47 Btu/Wh (30% better than a single capacity heat pump representative of high efficiency units in the market place today), and an SEER = 9.33 Btu/Wh for the weather profile observed at the field test site during the first test year.

25118 **(PB—87-153920/XAB) Contaminated-vapor rotary-screw heat pump. Final report, August 1983-June 1986.** Ruggles, A.E.; Becker, F.E. (Thermo Electron Corp., Waltham, MA (USA)). Jul 1986. 85p. (TE—4326-98-86). NTIS, PC A05/MF A01.

See also PB—85-174894.

In many industrial processes, large quantities of waste energy are often liberated in the form of low-pressure waste steam and low-grade waste heat, such as sensible heat of liquids or gases and latent heat of condensible gases. Economic recovery is often difficult due to such factors as low-temperature levels and contamination of the steam. In industrial processes that utilize steam directly, or as a mode of energy transport, waste low-grade energy can be efficiently recovered and upgraded in the form of high-pressure steam by means of a contaminated-steam heat-pump system. A prototype gas-fired steam heat pump was developed for use with contaminated steam. The system uses a rotary-screw positive-displacement compressor driven by a natural gas engine. Capable of compressing 2000 cfm of contaminated steam from atmospheric pressure up to 60 psig, the system has been successfully tested in an animal-rendering-plant application. The system has operated for more than a year, with fuel savings of 58T compared to using steam produced in a standard 80% efficient boiler.

25119 **(PNL—6079) R and D opportunities for commercial HVAC [heating, air conditioning, and ventilation] equipment.** Chiu, S.A.; Zaloudek, F.R. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1987. Contract AC06-76RL01830. 95p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87006738.

The overall objective of this project is to identify and characterize generic HVAC equipment research that will provide the best investment opportunities for DOE R and D funds. The prerequisites of a DOE research program include research efforts that are potentially significant in energy conservation impact and that are cost-effective, long-term, and high risk. These prerequisites form the basic guidelines for the R and D opportunities assessed. The assessment excludes the R and D areas that have potential or current private sector sponsors. Finally, R and D areas which are included in DOE programs generally are not addressed.

25120 **(PSB-IoEE-TM—97) Critical survey of dynamic mathematical models of refrigeration systems and heat pumps and their components.** James, K.A.; James, R.W.; Dunn, A. (Polytechnic of the South Bank, London (UK). Inst. of Environmental Engineering). Mar 1986. 44p. British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ.

The review presented covers models of compressors, condensers, evaporators, expansion valves, suction-liquid line heat exchangers, inter-coolers for two stage systems and pipe connections. These models were dealt with separately and critically compared. The future role for modelling is discussed and areas for future research are identified. It is concluded that many of the models available are lacking in experimental validation and that a flexible modelling environment is required in which suitable component models can be flexibly linked.

25121 **(STF—15A85046) Glazed atriums - Effects of ventilation strategy and thermal capacity on climate and HVAC loads.** Boerresen, B.A.; Harsem, T.T. (SINTEF, Trondheim (Norway)). Sep 1985. 17p. NTIS (US Sales Only), PC A02. File Number DE87751686.

In this report a fully climatized glass covered atrium is studied. Running conditions are as for a hotel. The choice of ventilation concept, shading and thermal capacity highly effects the summer conditions and cooling system design. Peak loads and installation costs will often relate to summer conditions, while the energy use and energy costs are close related to the heating season. It is clearly demomstrated that climatization, i.e. cooling and heating only with the use of ventilation air will cause problems. The use of heating and cooling connected with floor areas or walls will be demonstrated in later works. 1 drawing, 2 tables.

25122 **(STF—45A85003) Measurement and regulation of waterborn energy.** Naavik, G. (SINTEF, Trondheim (Norway)). Sep 1985. 62p. (In Norwegian). NTIS (US Sales Only), PC A04. File Number DE87751699.

The report gives a survey on the existing temperature recorders, liquid flow indicators, and control valves for multi-tubular space heating systems. Profitability analyses on such waterborn systems, are presented. The report also discusses the development of a control and flow-recording valve. 39 drawings, 4 tables.

25123 **Changes in indoor temperatures after retrofit based on electricity billing and weather data.** Hirst, E. (Oak Ridge National Lab., TN). *Energy Systems and Policy;* **10**: No. 1, 1-20(1987). Contract AC05-84OR21400.

The behavioral response (e.g., changes in indoor temperatures, attention to window and door openings) to residential technical efficiency improvements (e.g., attic insulation, storm windows) is largely unknown because there is almost no empirical evidence on the subject. Detailed electricity billing and daily outdoor temperature data for three years (from mid 1981 through mid-1984) were analyzed for households that received financial assistance from the Bonneville Power Administration to retrofit their homes in 1982 or 1983 and for eligible nonparticipants. Results suggest that the 1982 and 1983 participants increased indoor temperature settings after retrofit by about 0.4 and 1.3°F respectively. Nonparticipants, on average, left their indoor temperatures unchanged between the first and second years and then increased temperatures by about 1/4°F between the second and third years. Participants thus increased temperatures more than did nonparticipants, by roughly 0.4-1.0°F, which supports, the notion of a take back effect. These results should be viewed cautiously because of the strong assumptions embodied in the analytical method and the large variation across households.

25124 **Examination of the consumer decision process for residential energy use.** Dinan, T.M. (Oak Ridge National Lab., TN). *Energy Systems and Policy;* **10**: No. 4, 345-371(1987). Contract AC05-84OR21400.

Numerous studies have examined the factors that influence consumers' energy-using behavior. A comprehensive review of these studies was conducted in which articles from different research disciplines (economics, sociology, psychology, and marketing) were examined. This paper provides a discussion of a subset of these studies, and based on findings of the review, offers recommendations for future research. The literature review revealed a need to develop an integrated framework for examining consumers' energy-using behavior. This integrated framework should simultaneously consider both price and nonprice related factors which underlie energy use decisions. It should also examined the process by which decisions are made, as well as the factors that affect the decision outcome. This paper provides a suggested integrated framework for future research and discusses the data required to support this framework. 23 references, 3 figures.

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25125 **(ORNL—6351) Motor vehicle MPG and market shares report: Model Year 1986.** Hu, P.S.; Buckels, L.S. (Oak Ridge National Lab., TN (USA)). Feb 1987. Contract AC05-84OR21400. 250p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE87007836.

This issue reports the estimated sales-weighted fuel economies, sales, market shares, and other estimated sales-weighted vehicle characteristics of automobiles and light trucks for model year 1978 through 1986. Monthly vehicle sales data are used as weighting factors in the sales-weighted estimation procedure, enabling the estimates to reflect averages for the overall new vehicle fleet. Comparisons and observations are highlighted on the trends in these vehicle characteristics from one model year to the next. Analyses are carried out on the fuel economy changes to determine the factors that have caused the changes.

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REFER ALSO TO CITATION(S) 24414, 24494, 24495, 24554, 24585, 24592, 24593, 24697, 24757, 24907, 24952, 25118, 25120, 25216, 25217, 25479, 25496, 25498, 25499, 25813

25126 **(CMI-R—842240-4) Substitution between oil, gas and coal in UK industrial steam raising.** Moxnes, E.; Nesset, E. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Mar 1985. 65p. NTIS (US Sales Only), PC A04/MF A01. File Number DE87751706.

The purpose of the study is to gain increased understanding of fuel substitution in industrial steamraising. The process of steam raising is found to be homogenous with only minor systematic cost differences between the smaller firetube boilers and the larger watertube boilers. Thus, it has been possible to develop a simulation model to describe substitution between oil, gas and coal, based on a priori information. The model chooses the cheapest fuel alternative measured by the sum of operating costs and anualized capital costs, and it takes account of the fact that different steam producers face slightly different costs. The model captures the dynamics of substitution through explicit formulations of investments in, and depreciations of the boiler stock. Feeding the model with the historical fuel prices from 1960 to 1980 for United Kingdom, it replicated historical market shares for oil, gas and coal remarkably well. 18 drawings, 20 tables.

25127 **(CMI-R—852260-4) Dynamics of interfuel substitution in the OECD - Europe Industrial Sector.** Moxnes, E. (Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)). Feb 1986. 37p. NTIS (US Sales Only), PC A03. File Number DE87751707.

The purpose of the study is to gain increased understanding of the dynamics of inter-fuel substitution in the industrial sector of OECD countries in Europe. A model of fuel substitution has been developed for the purpose. This model is on a stuctural form rather than on a reduced form. The model gives a very good explanation of historical development, just from a priori data and without time-series fitting. Consistency between a priori parameters and historical development serves to validate the model. The model explains endogenously by its structure what often is referred to as structural changes in the market. For example, if price elasticities are calculated from the model equations, one finds that they change as a function of fuel prices and time. These features of the model make it well suited to make forecasts of industrial energy demand. Derived demand curves for 1990, 1995, 2000 and 2005 indicate future sensitivity of gas demand to changes in gas and oil prices. 13 drawings, 3 tables.

25128 **(CONF-8610169—) Proceedings of DOE industrial heat pump workshop.** (Department of Energy, Washington, DC (USA). Office of Industrial Programs; USDOE Idaho Operations Office, Idaho Falls). 1986. Contract AC07-76ID01570. 292p. NTIS MF A01; 2; GPO Dep. File Number DE87007089.

From Department of Energy industrial heat pump workshop; Atlanta, GA, USA (14 Oct 1986).

The workshop was to provide technology familiarization to participants active in the application, marketing, or design of heat pumps in industry. Its primary goal was to stress the importance of properly locating heat pumps in an energy-optimized process with secondary goals of providing information on availability, successful applications, utility experiences, advanced R and D efforts, and DOE's role. Group discussions are given. Fourteen papers are included. (DLC)

25129 **(DOE/CE/40629—1) Energy effective contaminant removal from closed loop recovery systems for cyanide based electroplating.** Williamson, R.C.; Williamson, W.R.; Roy, C.H. (LI-CON, Inc., Pensacola, FL (USA)). Mar 1987. Contract AC07-83CE40629. 51p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007962.

An ultra-low-temperature heat pump evaporator was developed to provide a feasible alternative to conventional chemical treatment and sludge disposal of heat sensitive cyanide based electroplating wastes. The evaporator system, trademarked Fridgevap, was successfully tested on a cadmium cyanide plating line, proving the feasibility of recovering and returning the plating solution to the bath. The purpose of the project reported here was to develop and test an auxiliary crystallizer to continuously precipitate sodium carbonate decahydrate (washing soda) contaminants, thereby enhancing the effectiveness of materials recovery. The combined evaporator and crystallizer system underwent limited testing on both a cadmium and a zinc cyanide plating line. This report describes and discusses the development and testing of the prototype closed loop recovery system and the patented heat exchanger which made the system possible. Included is a comparison with conventional chemical precipitation and sludge disposal.

25130 **(DOE/CS/40379—T1) Energy integrated dairy farm system in Georgia: Technical manual, Mathis/P & M Dairy Farm, Social Circle, Georgia.** Walsh, J.L. Jr.; Ross, C.C.; Lamade, R.M. (Georgia Inst. of Tech., Atlanta (USA). Economic Development Lab.). Sep 1986. Contract FC07-80CS40379. 142p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87007598.

This manual describes a project sponsored to optimize energy generation and utilization in the agricultural or food processing industry. The particular project involves the Mathis/P and M Dairy Farm located in Social Circle, Georgia (about 60 miles east of Atlanta). The farm is designed for a 550 milking cow herd and produces certified raw milk for sale to a processing plant located in Atlanta. The project converted the Mathis/P and and M Dairy into an energy integrated dairy farm system (EIDFS) in which the interaction of the subsystems and components are modified such that the energy resources of the farm are optimized. This manual is a description of the system, subsystems and components composing the Mathis EIDFS and is primarily intended for farmers, extension agents, and equipment manufacturers who might be involved in future EIDFS projects. Cogeneration using biogas from manures and heat recovery from the refrigeration machinery were among the options chosen.

25131 **(DOE/NBM—7007676) Roles of electricity: Glassmaking.** Burwell, C.C. (Oak Ridge Associated Universities, Inc., TN (USA)). Sep 1986. Contract AC05-76OR00033. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007676.

The electric route to glassmaking offers substantial environmental and cost benefits and a means to substitute US sources of coal and uranium for declining reserves of oil and gas. The use of electricity as a source of heat in glassmaking is competitive in cost of capital for expansion of production and in terms of energy costs, especially following deregulation of the price of natural gas. Between 1962 and 1980 the amount of total energy used per unit of glass product declined by 23% while the use of electricity (per unit of product) increased by 60%. The energy saved in using electric glass melting is equal to or greater than the energy needed to produce the electricity. Other benefits of electric heat include improved working conditions and improved efficiency.

25132 **(DOE/NBM—7007677) Roles of electricity: Petroleum refining.** Sigmon, E.B. (Oak Ridge Associated Universities, Inc., TN (USA)). Oct 1986. Contract AC05-76OR00033. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007677.

Petroleum refiners used 91% more utility-produced electricity in 1982 per barrel of crude oil refined than in 1962, while cutting consumption of other fuels by 24%. Thus, even though US refineries processed the same amount of oil in 1982 as they did in 1972, fuel consumption was lower by 140 million barrels of oil (equivalent to 8% of imports in 1982). The expansion is an evolutionary change, not a revolutionary one, and appears to be driven by major long-term trends.

25133 **(ED—91/54) Improving fuel usage in an aluminium reverberatory melting furnace by using high velocity heavy fuel oil burners. Final report.** (Department of Energy, London (UK). Energy Efficiency Office; British Steel Corp., Rotherham. Swinden Labs.; UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; British Alcan Aluminium Ltd., Warrington). Oct 1986. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751844.

In 1980, British Alcan Aluminium Ltd. decided to investigate the potential benefits of high-velocity burners. It was considered that optimum energy savings would only be achieved if the high velocity burners were operated in conjunction with modern instrumentation, which facilitates more efficient furnace control, and improvements were made to the refractory linings of the furnace. Calculations indicated that six high-velocity burners, together with the other improvements, could reduce fuel costs by approximately 30% and give a payback period of approximately two years. Overall, the possible future replication saving to the aluminium industry was estimated, at the start of the project, to be Pound 750,000/year.

25134 **(ED—97/175) Optimisation of energy utilisation on ladle pre-heating and drying systems in an electric arc melting shop. Final report.** (Department of Energy, London (UK). Energy Efficiency Office; UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; United Engineering Steels Ltd., Wrexham (UK)). Nov 1986. 44p. NTIS (US Sales Only), PC A03/MF A01. File Number DE87751842.

The installation of two ladle pre-heating stations at United Engineering Steels Ltd. has resulted in an overall energy saving of 37,000 GJ/year worth Pound 110,000/year. This represents 25% of the energy previously consumed in ladle heating. One of the ladle pre-heating stations incorporates high velocity horizontally-fired burners, and the other station has a recuperator capable of pre-heating the combustion air to 400°C. The capital costs and payback periods for the two stations are given. The significant savings that can be achieved through the efficient use of energy in ladle heating are discussed, and the importance of the position of the ladle heating station, adequate training accompanying the introduction of high technology equipment and the design of the equipment are discussed.

25135 (ED—102/81) Use of oxygen with a high carbon content shale clay to reduce firing energy in brickmaking. Final report. (Department of Energy, London (UK). Energy Efficiency Office; British Ceramic Research Association, Stoke-on-Trent; UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.; Ibstock Brick (Nostell) Ltd., Wakefield (UK)). Nov 1986. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE87751843.

For a total installation cost of Pound 17,580, a demonstration project at Ibstock Brick (Nostell) Ltd. has achieved minimum savings of Pound 38,736/year with a simple payback period on this base figure of 5.4 months. Ibstock Brick's Nostell works had already installed oxygen injection equipment prior to the demonstration. Preliminary investigations were carried out and the kiln was fitted with two additional rows of oxygen lances, a variable speed control exhaust fan and a secondary cooling fan with motorised damper control. By increasing the use of oxygen and using high carbon raw materials, energy savings worth approximately Pound 22,000/year, savings on raw material costs worth Pound 23,456/year and increased throughput, providing potential for increased profitability were achieved.

25136 (EPRI-EM—4571) Electric infrared process heating: State-of-the-art assessment: Final report. (Battelle Columbus Div., OH (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 63p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920323.

Electric infrared (ir) process heating employs electrical resistance to heat an emitting material specifically for the purpose of generating thermal (infrared) radiation. While often perceived as a "niche" technology, electric ir heating is actually adaptable to a variety of applications. Electric ir heating is a mature electrotechnology which lacks a nationally prominent advocate to sponsor and promote its efficient use. Electric ir heating unit sales are currently growing at a 10 to 12% per year rate and the US market exists for potentially greater rate increases.

25137 (EPRI-EM—4949) Radio-frequency dielectric heating in industry: Final report. Wilson, T.L. (Thermo Energy Corp., Palo Alto, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 176p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920340.

This report is written to assist utility staff engineers in searching for new applications of RF dielectric heating in industry. RF (radio frequency) dielectric heating is in daily use in industry for plastic welding, drying, and glue setting, but has many more potential applications. In this report successful applications are reviewed, and the reasons for their success are described. Based upon the results of these applications, guidelines for the successful application of RF dielectric heating in industry are formulated.

25138 (EPRI-EM—5083) Industrial and commercial cogeneration case studies: Final report. Limaye, D.R.; Celentano, D.L. (Synergic Resources Corp., Bala-Cynwyd, PA (USA); Science Applications International Corp., Los Altos, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 187p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920325.

While cogeneration is receiving increasing attention on the part of electric utilities and their industrial customers, there is no comprehensive information base on the technical and operational characteristics of cogeneration systems. This report describes 30 existing industrial and 5 existing commercial cogeneration systems. The systems were selected to represent a diversity of prime movers, thermodynamics cycles, industry type, fuel type, ownership, geographic location and utility interface. The information was developed through direct contact with owners or operators. Site visits were made to some of the facilities. The case studies point out the diversity of industrial and commercial cogeneration systems and demonstrate their high level of efficiency and reliability. It should be noted that the information was developed in 1984 for the industrial case studies and in 1985 for the commercial case studies.

25139 (ESC—38) Energy consumption for steel production. An example of energy accounting. Van Wees, F.G.H.; Over, J.A.; Van Buuren, J.E.; Ronde, P.M.B. (Stichting Energieonderzoek Centrum Nederland, Petten. Energie Studie Centrum). Nov 1986. 54p. (CONF-861010—23). NTIS (US Sales Only), PC A04/MF A01. File Number DE87751768.

From 13. world energy conference; Cannes, France (5 Oct 1986).

In support of the Energy Consumption in Industrial Processes Working Group the authors formed a study group to examine the steel process. The steel production process is explained and approximate indications for the energy consumption per separate operation are provided. A number of technological changes in the various process routes have caused a significant decrease in the specific energy consumption. However, there are also developments (quality requirements set to finished products; environmental measures) which tend to increase energy consumption. Effective comparison of the situation in the selected countries by analysis of the existing global information is limited, because the resulting figures are rather suspect due to the unclear boundaries of the described systems and the differences which arise because of the local (energy) situation in a country. For a better understanding of the differences in the energy consumption of the separate steps of the integrated steel production route, the group recommends the use of the so-called Roll-up Method. This method can also be used for other integrated production processes such as those for base chemicals. The information collected through a special inquiry using the Roll-up Method gives a better basis for an assessment of the (possible) future energy consumption in the steel industry. This is illustrated for a limited number of countries and production sites. 3 figs., 9 tabs., 8 refs., 1 app.

25140 (ESC-WR—86-21) Investments in energy conservation. Imports of components. Report written for OBE/IREM. Van Wees, F.G. (Stichting Energieonderzoek Centrum Nederland, Petten. Energie Studie Centrum). Oct 1986. 130p. (In Dutch). Energie Studie Centrum ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

This report is a condensed version of ESC-36, an earlier published report of the Energy Study Centre of the Netherlands Energy Research Foundation ECN. That report had been based on information over the period 1984-1985 and described the role of Dutch industry with respect to supplying equipment for energy conservation purposes. For the described cases the role of foreign supplies of equipment is outlined in a new, added chapter. It deals with the period 1990-2000. 13 app.

25141 (NYSERDA—87-1) Investigation of energy efficiency in the electroplating industry: Final report. (VTEC Labs., Inc., Bronx, NY (USA)). Jan 1987. 67p. New York State Energy Research and Development Authority, Two Rockefeller Plaza, Albany, NY 12223. File Number TI87900587.

The electroplating industry is heavily dependent on electricity for process use. This problem is compounded by the fact that a large concentration of electroplaters in New York State are located in the New York City area, where local utility rates are high. To understand energy consumption of electroplaters, 15 energy surveys were performed to see if any energy usage trends exist and what subsequent methods could reduce them. Through the surveys it was established that most electroplaters could reduce their energy bills by performing minimal repairs such as replacing faulty steam traps and repairing steam leaks. To achieve greater energy savings would require additional equipment such as a demand controller for exhaust fans, better controls for heating solution tanks or insulate heated solution tanks. To achieve energy savings of 30% or more, major capital equipment would be required. Two technologies recognized for this purpose are computer control of the process equipment and cogeneration. Both methods would require modification to fit the electroplaters' needs, but remain as viable candidates.

25142 (ORNL/TM—10311) **Resource Conservation and Recovery Act (RCRA) new-employee training manual for the Operations Division RCRA personnel.** Barkenbus, B.D. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 402p. NTIS MF A01; 2; GPO Dep. File Number DE87007881.

This manual has been prepared for the training of new employees who will work with RCRA hazardous waste management in the Operations Division. It will be taught by a person who is trained in hazardous waste regulations/procedures. It consists of nine modules. The topics of these modules are: RCRA Training, Hazardous Waste Regulations, Transportation Regulations, Hazardous Waste Management at ORNL, Chemical Hazards and Safety, Hazardous Waste Operations Training, Sampling of Hazardous Waste, Hazardous Waste Identification/Classification, and RCRA Contingency Plans and Emergency Procedures. The on-the-job training areas are identified in the modules. They are an integral part of training.

25143 **(PB—87-154019/XAB) Advanced cogeneration and combined-cycle system, Topical report, April-October 1986.** Schneider, P.H.; Duffy, T.E. (Solar Turbines, Inc., San Diego, CA (USA)). Nov 1986. 34p. (SR—86-R-5321-08). NTIS, PC A03/MF A01.

A preliminary design was completed of an advanced cogeneration and combined-cycle system for industrial plants. The system incorporates a gas-turbine engine and novel steam generator and back-pressure steam turbine. Substantially improved economic returns are provided by a combination of reduced initial cost, increased efficiency of fuel utilization, and flexibility to follow the varying electrical and thermal demands of industry. Subsequent phases of the program will include detail design, fabrication, and test of the system which can produce 13.4 MW of electrical power and 109,000 pounds per hour of steam for the thermal process.

25144 (PNL-SA—13481, pp 1.1-1.13) **Metal-selective electrodialysis membranes for electrowinning pure metals from impure solutions.** Huggins, D.K. (AMAX Extractive Research and Development, Inc., Golden, CO). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

An innovative concept for reducing energy usage and increasing productivity in the metals, minerals, and mining industries is proposed for development. The concept is an electrowinning cell for recovering pure metals directly from impure solutions. The key feature of the concept is the use, in the cell, of a unique electrodialysis membrane which is selective for only one metal. This membrane allows impure metal solutions to be fed directly to the cell. Thus, the separate purification operation normally required in processes for recovering pure metals from impure solutions is eliminated, which saves energy and improves productivity. The concept is applicable to any impure, metal-containing stream and is particularly applicable to the metals and mining industries, where metals such as copper and zinc are recovered by electrowinning. The concept is also applicable to waste streams from electroplating and metal finishing plants and to plants in the electronics industries making printed circuit boards and high energy-density batteries. The major effort of the proposed research program would be developing the metal-selective electrodialysis membrane. The fundamental physical and chemical functions which the membrane must possess to be successful are discussed. Analogies with existing, highly selective solid-supported liquid membranes, ion-selective electrode membranes, and sandwich-type liquid electrodialysis membranes are presented to show that the proposed membrane is feasible and its chance for successful development is good. The potential energy savings are estimated for applying the innovative concept to recovering copper and zinc in the mining industry. The concept's application to the metal plating and finishing industries is also discussed.

25145 (PNL-SA—13481, pp 2.1-2.10) **Float casting - a concept for continuous casting of thin sheet carbon steel.** Dolan, J.J. 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

The objective of this work is to produce a workable process for continuously casting steel sheet from molten steel by floating the molten steel on a bed of molten lead. Lead appears to have the characteristics of density, a working temperature range and theoretical immiscibility with steel at 1600°C, so that thin cast steel sheet having a 3 millimeter (mm) to 6 mm thickness and a 1250 mm width could be formed by solidification while floating on the molten lead. Major problems remain to be solved. The actual amount of lead which might mix with the steel is controversial and must be tested empirically. A feeding mechanism to meter the proper profile of molten steel across the molten lead must be developed, and the metallurgical structure and finish of the free side of the floating section must be dealt with. Given time, effort and proper funding, these problems are considered tractable and the payoff for success enormous. A successful sheet casting system would generate energy savings equivalent to 20 million barrels of oil per year. This system would eliminate between $500 million to $1 billion of capital equipment in conventional steel sheet production. Research in competing technology, largely funded by the DOE, is currently under way; however, the time frames for development are 5 to 15 years and involve far more complicated processes than float casting. The work to be done with float casting involves quantifying exactly the mixing of any lead with steel at 1600°C and then moving to a small pilot line (6 mm x 313 mm) to perfect float casting techniques and to determine the composition of the as-cast section. The pilot line must be sufficiently successful to induce an operating steel company to invest in a prototype production line for full commercial operation.

25146 (PNL-SA—13481, pp 3.1-3.8) **Hydrometallurgical separation using predispersed solvent extraction.** Sebba, F.; Michelsen, D. (Virginia Polytechnic Institute and State Univ., Blacksburg). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

The novel solvent extraction process called predispersed solvent extraction was examined in some detail using copper ions as the sample metal to be extracted. Information was obtained on the most suitable operating conditions, particularly the rate of solvent addition, rate of addition of the small bubbles used to float the solvent, and completeness of the extraction. A self-contained pilot unit for continuous operation was constructed and some preliminary data were obtained. Preliminary results show that this method has considerable advantages compared with conventional solvent extraction, particularly for economy of solvent needed, simplicity of equipment needed, economy of power costs, and cleanness of separation.

25147 (PNL-SA—13481, pp 4.1-4.14) **Acoustically aided fine-particle processing.** Feke, D.L.; Hazony, D. (Case Western Reserve Univ., Cleveland, OH). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

The efficiency of many fluid-solid contacting operations depends directly on the size of the particles being processed. For processes controlled by heat or mass transport, higher transfer coefficients are expected for small particles, and thus operating with very fine particles should increase efficiency. However, the particles used in current practice are the smallest that can be conveniently handled. Excessive pressure drops in packed bed contactors and inefficient means to separate fine particles from their supporting fluids prohibit operation with very fine particles. The purpose of this study was to investigate the use of acoustic radiation to enable the efficient processing of fine suspended particles. A theory is presented to predict the conditions under which acoustic pressure can be used to trap fine particles in an expanded configuration at fixed locations relative to a flowing fluid and thus alleviate excessive pressure drops. Circumstances may be predicted under which acoustic pressure can move fine particles through stagnant fluids, thereby aiding the separation of these particles from the fluid. The theory accounts for particle size, density, intensity of the acoustic radiation, and magnitude of the relative velocity between the particle and the fluid. Based on predictions, it is concluded that the potential for significant energy savings is large. To practicably implement this concept, planar standing waves must be produced within a sealed vessel. An acoustic chamber consisting of a sealed glass tube, fitted with metal end pieces driven by piezoelectric transducers was constructed to investigate the possibility of producing such waves. While the chamber exhibited some fluid-phase standing-wave activity, interferences in the signal from reflections and transmission of the signal through other components of the cell proved overwhelming.

25148 (PNL-SA—13481, pp 5.1-5.13) **Temperature amplifiers using complex compounds.** Rockenfeller, U. (Desert Research Institute, Boulder City, NV). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

Industrial processes can be improved by using industrial heat pumps to upgrade waste heat and return it to the process. The feasibility, working fluid selection, and performance of several new concepts for solid-gas heat pumps were investigated. The temperature stabilities of the working fluids of the two types of heat pumps currently being used, heat amplifiers and temperature amplifiers, are compared. One single-stage and two different two-stage temperature amplifier concepts are discussed for possible application between 100°C and 300°C. Several ammoniated complex compounds and hydrates were selected as working media pairs. Computer modeling was performed for the single-stage concept with two ammoniated complex compounds as the working fluid. The most crucial properties were experimentally verified for some of the candidate working fluids. The preliminary analyses led to promising results. Some of the selected working fluids are stable even at temperatures exceeding 300°C. The predicted temperature lifts and coefficients of performance are superior to state-of-the-art and solution-type temperature amplifiers. Moving parts such as solution pumps, which lead to parasitic power demands, are not required for the solid-gas concepts. This improves the performance characteristics and avoids high-temperature material problems. The capital investment for the solid-gas concepts is expected to be lower than for solution-type temperature amplifiers.

25149 (PNL-SA—13481, pp 6.1-6.13) **High-temperature heat pump.** Jeter, S.M. (Georgia Institute of Technology, Atlanta). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

Research on an innovative high-temperature heat pump is described. The preferred concept is a high-temperature analog to the familiar vapor-compression cycle. The concept is innovative in that a solid state component, beta-alumina solid electrolyte (BASE), is used to perform the compression function. This concept promises to be reliable and efficient at the high temperatures required for many applications in the chemical process industries. The economic viability of the concept depends on the relative costs of electric power to energize the BASE compressor compared with alternative fuels for direct heating, but the BASE heat pump could be an attractive alternative.

25150 (PNL-SA—13481, pp 7.1-7.10) **Impressed electric field dispersion of plugging solids.** Woinsky, S.G. (Research Services, Inc., Irvin, CA). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

One objective of this work was to prove that passing alternating electric current longitudinally through distillation packings that are made from high-efficiency knitted wire mesh would prevent plugging with simulated industrial corrosion product solids. A second objective was to provide data for follow-on cost/benefit analysis and large-scale tests. The effects of alternating current level and frequency were studied using a number of commercial packing styles and simulated solid plugging systems in both air-water and air-hydrocarbon systems in transparent plastic columns that were 3 inches in diameter. Rough economic calculations indicated that the approach would be currently economical for a number of situations at a current density of about 70 amp/ft^2. The economics could be further improved by various means. However, experimental results were inconclusive up to a current density of 425 amp/ft^2, although measurements on current flow distribution indicated variations as large as 35 to 1. These variations suggest that the electrical connection means used to conduct electricity to and from the packings may have allowed localized plugging, thus masking any positive results. The approach has the potential for an annual US energy savings of 350 trillion Btu (equal to 58 million barrels of oil and $1.4 billion saved each year). Therefore, Research Services, Inc. plans to continue work and investigate small-scale electrical connection means which could approach that achievable on a commercial scale. If they are successful, additional work will also be required to realize the potential of this concept. That work will include analysis of commercially available column wall insulation materials required to make the concept commercially feasible, more detailed cost/benefit analysis, and large-scale testing with existing commercial packings and modified packings suggested by the results of this work.

25151 (PNL-SA—13481, pp 8.1-8.15) **Steam-methane reforming in molten carbonate salt.** Erickson, D.C. (Energy Concepts Co., Annapolis, MD). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

The feasibility of a new approach to reforming methane has been assessed. The new approach uses a melt of alkali carbonate, heated by submerged combustion, as both heat carrier and catalyst for the reform reaction. Because the conventional reformer tubes and catalyst are eliminated, the reformer can operate at a higher temperature and pressure, and lower steam/methane ratio. The feasibility assessment includes a review of the current state-of-the-art in conventional reforming, an equilibrium heat and mass balance calculation of the new reformer, a review of pertinent prior research on molten carbonate and other molten salt systems, a projection of the energy savings and economic benefits of the new reformer, and a review of critical engineering concerns anticipated. The assessment also includes a plan for future R & D steps necessary to practicably apply the reformer design. The main conclusions are that the proposed molten carbonate reformer is technically feasible. It promises energy savings of 10% to 20% for hydrogen production, and some savings in capital investment are also probably. The nationwide impact of a successful development program would be a natural gas savings of at least 30 trillion ft^3 per year (0.03 quad/year, equivalent to 15,000 bbl crude oil per day). The engineering concerns are salt containment and corrosion, salt chemistry, salt circulation, salt entrainment, and reform kinetics. Proven measures are available to resolve each of these concerns. The immediate research necessary, advancing the reformer through bench-scale development, will require #320,000 and 2.5 years. Subsequent R & D encompassing a semi-works scale pilot plant would require a $2.5 million effort over an additional 2.5 years.

25152 (PNL-SA—13481, pp 9.1-9.12) **Producing maleic anhydride using C_4 hydrocarbons.** Ozkan, U. (Ohio State Univ., Columbus). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

Catalytic selective oxidation reactions are an integral part of today's modern petrochemical industry. In these processes, a hydrocarbon reacts with oxygen in the presence of a solid catalyst to produce a partially oxygenated hydrocarbon derivative. The presence of an active and selective catalyst is essential in these reactions to achieve a high reaction rate at lower temperatures and also to produce only the desired products while restricting the complete oxidation of the hydrocarbon. Maleic anhydride is a very valuable petrochemical intermediate which is produced through a selective oxidation process. Although benzene currently is the most widely used feedstock for producing maleic anhydride, C_4 hydrocarbons (butanes and butenes) have several economical and environmental factors that make them a more attractive feed material for maleic anhydride production than benzene. Evidence in the literature indicates that the catalytic behavior of selective oxidation catalysts can be modified dramatically by using impurities or promoters. Studying the fundamental processes involved during synthesis and applying selective oxidation catalysts would help in the solid-state design of selective and active catalysts. In this research program, initial studies have been performed to investigate the selective oxidation of C_4 hydrocarbons to maleic anhydride by molybdenum oxide catalysts containing impurities or promoters in the form of simple molybdates. The results of these initial investigations have shown that molybdenum trioxide, which has no selectivity for maleic anhydride formation in its pure form, can achieve a high selectivity when doped with simple molybdates, which are also completely nonselective in their pure form.

25153 (PNL-SA—13481, pp 10.1-10.15) **Countercurrent extraction through stabilized predispersed solvents.** Michelsen, D.L.; Sebba, F.; Wallis, D.A. (Virginia Polytechnic Institute and State Univ., Blacksburg). 13 Nov 1985. NTIS, PC A08/MF A01. File Number DE86003536. (CONF-851166—).

From Industrial innovative concepts fair; Arlington, VA, USA (13 Nov 1985).

Oil core aphrons (predispersed solvents) can be made as a 90% dispersion of 2 to 50 micron solvent droplets in a 10% continuous water phase. Aphrotic solvents have moderately high dielectric constants and do not contain acidic hydrogen. Because the water is in the continuous phase, when these polyaphrons are introduced as the solvent source for extracting solute from a feed, they disperse with slight agitation into individual aphrons, producing a very large surface area for mass transfer. Dispersion studies have confirmed the superior performance of polyaphrons that are made using 0.01% dodecyl pyridinium chloride or 0.01% lauric acid added to the decane and mixed slowly into a 4 g/l foaming solution of sodium dodecyl benzene sulfonate. Mixer-separator studies have shown that the aphrons have high surface areas and therefore provide rapid mass transfer in removing trace-dissolved ortho dichlorobenzene from water. Countercurrent phase separation studies have demonstrated the feasibility of using oil core aphrons as a solvent source for countercurrent extraction. Phase mixing and separation of the solvent droplets are easily achieved and extraction looks promising, particularly for systems with low solvent/feed ratios. By using a colloidal gas dispersion to assist mixing and to piggy-back the predispersed solvent to the surface, flotation of the oil is enhanced and solvent loss of finely charged polyaphrons to the raffinate is minimized. Carryover solvent in the raffinate can be skimmed using flotation with polyelectrolytes and a fine air dispersion.

25154 **(STF—15A85028) Greenhouse stove. Final report.** Karlsvik, E. (SINTEF, Trondheim (Norway)). 20 May 1985. 15p. (In Norwegian). NTIS (US Sales Only), PC A02/MF A01. File Number DE87751696.

The report deals with the development of a furnace for CO/ sup 2/- production and heating purposes in greenhouses. 2 drawings, 1 table.

25155 **Effects of silver and group II fluoride solid lubricant additions to plasma-sprayed chromium carbide coatings for foil gas bearings to 650 C.** Wagner, R.C.; Sliney, H.E. (Lewis Research Center, Cleveland, OH). *Lubrication Engineering;* **42**: 594-600(Oct 1986).

A new self-lubricating coating composition of nickel aluminide-bonded chromium carbide formulated with silver and Group II fluorides was developed in a research program on high temperature solid lubricants. One of the proposed applications for this new coating composition is as a wide temperature spectrum solid lubricant for complaint foil gas bearings. Friction and wear properties were obtained using a foil gas bearing start-stop apparatus at temperatures from 25 to 650 C. The journals were Inconel 748. Some were coated with the plasma sprayed experimental coating, others with unmodified nickel aluminide/chromium carbide as a baseline for comparison. The additional components were provided to assist in achieving low friction over the temperature range of interest. Uncoated, preoxidized Inconel X-750 foil bearings were operated against these surfaces. The foils were subjected to repeated start/ stop cycles under a 14-kPa (2-Psi) bearing unit loading. Sliding contact occurred during lift-off and coastdown at surface velocities less than 6 m/s (3000 rPm). Testing continued until 9000 start/stop cycles were accumulated or until a rise in starting torque indicated the journal/bearing had failed. Comparison in coating performance as well as discussions of their properties and methods of application are given. 7 references.

3206 Municipalities And Community Systems

REFER ALSO TO CITATION(S) 24457, 24478, 24675, 24688, 24903, 24923, 24924, 24925, 24926, 24927, 24928, 24929, 24930, 24931, 24932, 24933, 24934, 25109

25156 **(AD-A—175124/7/XAB) Economic feasibility of fuel-cell energy systems for selected facilities on Wright-Patterson AFB, Ohio. Master's thesis.** Bird, S.A. (Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Systems and Logistics). Sep 1986. 113p. (AFIT/GEM/ LSM—86S-2). NTIS MF A01.

Availability: Microfiche copies only.

This thesis developed life-cycle costs of retrofitting fuel-cell-powered energy systems into existing facilities on Wright-Patterson Air Force Base (WPAFB), Ohio. These life-cycle costs were compared with existing costs for providing facility energy via commercially supplied electricity and natural gas and/or base-generated steam. Three facilities representative of the main facility types on WPAFB were examined: Military Family Housing (MFH) units, an office/classroom building, and an office/lab building. An analysis of the cost comparisons was performed to determine if fuel-cell energy systems can be economically competitive with existing facility energy-utilization systems. The results of this analysis are contained in Chapter IV.

25157 (DOE/CE/27460—T23, pp 8.195-8.202) **Avoided gigawatts through capital recovery fees and marginal cost pricing of electricity.** Rosenfeld, A.H.; Verdict, M.E. (Lawrence Berkeley Lab., CA). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154. Contract AC03-76SF00098.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

Advances in building technologies and appliance efficiencies have the combined potential to save up to 50% of the electricity demand of new buildings. This paper will discuss the advantages and disadvantages of using capital recovery fees for utility hookups and marginal cost pricing of electricity to defer the construction of more than 100 GW of peak power capacity power plants over the next 20-40 years, saving $10-20 billion per year in reduced electricity bills to consumers. 7 references, 1 figure.

25158 (DOE/CE/27460—T23, pp 8.217-8.219) **Incentive structure and level for BPA's purchase of energy savings.** Schick, H.; Vinnard, A. (Bonneville Power Administration, Portland, OR). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

The Purchase of Energy Savings (PES) is one of several commercial building retrofit activities currently being conducted by the Bonneville Power Administration (BPA) in the Pacific Northwest. For the PES pilot program, BPA negotiated a rate of return (ROR) on investment with each sponsor, which is applied on a job-by-job basis to calculate the BPA incentive. Using the ROR calculation, the sum of the value of the energy savings plus the incentive payments from BPA provide the sponsor with his negotiated ROR, if the project provides the estimated savings at the expected costs. Central to the calculation is reliable energy audit information on the costs and energy savings available in the building. This program is discussed.

25159 (DOE/CE/27460—T23, pp 8.220-8.223) **Privatization of the British Gas Corporation and its implications for energy efficiency.** Warren, A. (Association for the Conservation of Energy, London, England). Aug 1986. American Council for an Energy-Efficient Economy, 1001 Conn. Ave. N.W., Suite 535, Washington, DC 20036. File Number TI87005154.

In ACEEE (American Council for an Energy-Efficient Economy) 1986 summer study on energy efficiency in buildings: Volume 8, Proceedings from the panel on planning/forecasting.

British Gas Corporation (BGC) currently provides 60% of heat provision in British homes. The British government plans to sell BGC in November 1986. The impact of this sale on energy conservation in Britain is discussed.

25160 **(DOE/NBM—7007268) Feasibility of energy recovery for heat pump-assisted district heating and cooling from the Metro Renton wastewater treatment plant and effluent transfer system.** (VBB Allen, Salem, OR (USA); Systems Architects Engineers, Seattle, WA (USA); Shapiro and Associates, Inc., Seattle, WA (USA)). Sep 1986. 165p. NTIS, PC A08. File Number DE87007268.

The Municipality of Metropolitan Seattle (Metro) is constructing a 12-mile effluent transfer system (ETS) from its Renton wastewater treatment plant to Duwamish Head on Puget Sound. The preliminary stud (Phase I) concluded that the Renton treatment plant's effluent could feasibly sustain large amounts of heat pump output, i.e., 500 to 800 million Btu per hour. Further, the study identified eight locations along the ETS where district heating and cooling (DHC) networks could be favorably established to serve existing businesses and/or new growth. In December 1985 this second phase study was commissioned as a detailed assessment of specific customers in several of the recommended DHC development areas. The potential customers evaluated in this report include: Seattle-Tacoma International Airport, the Container Corporation carton manufacturing plant adjacent to the Renton treatment plant, Metro Transit Department's South Base, two buildings at the Boeing Developmental Center, and the Valley 405 Business Park adjacent to the Renton treatment plant. These potential users of effluent-based heating and/or cooling have been evaluated in terms of their heating and cooling demands, the type of effluent-based heat pump system necessary for serving them, and the economics of the effluent-based energy approach. In the cases of Sea-Tac and Container Corporation, the assessments also examine environmental and institutional issues, and generalized feasibilities for financing effluent-based systems.

25161 **(ECRC/M—2104) Design of an aerobic thermophilic sludge digestion system.** Morgan, S.F.; Winstanley, R.; Littlewood, M.H.; Gunson, H.G. (Electricity Council Research Centre, Capenhurst (UK)). Nov 1986. 13p. Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK.

The development of a viable aerobic thermophilic sludge digestion system to economically transfer oxygen from air while conserving the biochemically derived heat energy in the sludge is discussed. The existing VO2 Aeration System has low capital cost but limited technical performance. In this study higher specification and improved performance are demanded resulting in a system which has the following benefits:- 1) sludge is rendered stable and inoffensive, 2) sludge is substantially pathogen-free, 3) the volume of sludge for disposal is reduced, 4) the system has low capital cost, 5) the process has an acceptable energy cost, 6) it offers future opportunities for the export of heat energy.

25162 **(EPRI-EL—4957) Integrating dispersed storage and generation into power system control: Final report.** Chan, S.; Cheng, S.; Curtice, D. (Systems Control, Inc., Palo Alto, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. 248p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920321.

Dispersed storage and generation technologies provide utilities increasing amounts of electricity from unconventional sources. New computer codes help utilities integrate these technologies into daily system operations.

25163 **(NEI-NO—1) District heating from low-temperature sources.** Frivik, P.E. (Norsk Fjernvarmeforening, Oslo). 1984. 46p. (In Norwegian). (CONF-8404326—1). NTIS (US Sales Only), MF A01. File Number DE87751698.

From Seminar on district heating production; Hamar, Norway (2 Apr 1984).

The report deals with district heating systems equipped with heat pumps. Several types of heat pumps and heat sources are discussed. A brief evaluation of thermodynamic conditions and costs are given. 17 heat pump installations in Norway are described in an appendix. 37 drawings, 2 tables.

25164 (NP—7751733, pp 1-50) **Natural gas.** Strunk, G. 1982. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751733.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.3. Energy distribution.

In the framework of investigations about how to meet energy demand by energy sources other than heating oil in the area of the rivers Neckar and Rhine, this publication gives more detailed information on natural gas distribution. It describes the supply nets of the Mannheim municipal works, where gas distribution is effected by the high-pressure and low-pressure methods. The low-pressure nets consist mainly of ductile cast iron pipes, which are protected from corrosion by cement and bitumen layers. The cost of the nets depend on the cost of pipe construction and public works. These are determined by the embedding method, civil engineering conditions and price development. Corresponding cost analyses are made as regards embedding works for low-pressure gas pipes, distribution and under-distribution for certain settlement types, intermediate distribution and regional pressure control stations. Figure examples serve to illustrate the individual cost situations, for which also numerous diagrams and tables are given. (HWJ).

25165 (NP—7751733, pp 1-114) **District heat.** Strunk, G. 1982. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751733.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.3. Energy distribution.

In the framework of investigations about how to meet energy demand by energy sources other than heating oil in the area of the rivers Neckar and Rhine, this publication gives more detailed information on the distribution of district heat to the different settlement types. It first of all explains construction types such as canals, steel-coated pipes, pipes coated with asbestos cement and plastic-coated pipes, to go on to deal with distribution costs. Examples are given for the cost of subdistribution (calculation of net length and mean line cross-section; for certain settlement types: ST 1 ... 9, listing of type characteristics), for intermediate distribution and for the cost of house service connections (investments per customer and annual subdistribution cost). This technical contribution concludes with figures regarding the specific pumping power requirement and for heat losses. The individual costs are processed into numerous diagrams for the most important embedding pipe parameters. Equation elements used in the cost calculations are indicated. (HWJ).

25166 **(NP—7751733) Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources, gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.3. Energy distribution.** (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). 1982. 236p. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751733.

Subsection A.4.3 'Energy distribution' of research project ET 5286 A comprises the chapters: 1) Natural gas; 2) District heat;

3) Heating fuel oil; 4) Coke; 5) Comparing natural gas, district heating, heating fuel oil and coke for various types of settlements. Separate records are available for each of the 5 chapters.

25167 **(PB—87-145355/XAB) Field evaluation of methodology for measurement of cadmium in stationary-source stack gases. Final report.** Moseman, R.F.; Bath, D.B.; McReynolds, J.R.; Holder, D.J.; Sykes, A.L. (Radian Corp., Research Triangle Park, NC (USA)). Dec 1986. 133p. NTIS, PC A07/MF A01.

A laboratory and field-evaluation study was done to develop methodology for the measurement of cadmium in stationary-source stack emissions. Field evaluations were performed at a municipal solid-waste incinerator and a sewage-sludge incinerator. The methodology was tested through the laboratory and field-sampling validation phases to evaluate precision and accuracy of the proposed method. Colocated, quadruplicate flue-gas samples of nominally 30 and 60 dscf in 1 and 2 hours sampling time were collected to assure an adequate cadmium content, a representative sample, and the production of data to validate the method in terms of between-train precision. The overall accuracy and precision of the analysis procedure were 89.2% and 1.7%, respectively. The detection limit of the atomic absorption instrument was 0.03 ug/mL. The methodology proved to be a reliable sampling approach to determine cadmium emissions from the stationary sources tested.

25168 **Dynamics of energy savings due to conservation programs.** Hirst, E.; Keating, K. (Oak Ridge National Lab., TN). *Energy Systems and Policy;* **10**: No. 3, 257-273(1987). Contract AC05-84OR21400.

Most analyses of utility and government conservation programs assume that program-induced energy savings are constant over time. This assumption, although convenient, is almost certainly incorrect. The dynamics of program energy savings have two aspects. The first involves changes in savings for households that participated in a particular year. Their total and net savings depend on changes in electricity prices, incomes, general awareness of energy issues, and other conservation programs. Natural gas data from participants and nonparticipants in home energy audit programs in California, Michigan, and Minnesota show, for example, small increases in both net and total savings between the first and second postaudit years. Data from evaluations of financial incentive programs for residential retrofit in the Pacific Northwest, on the other hand, show increases in total electricity savings and declines in net savings between the first and second years after retrofit. The second aspect concerns changes in energy reductions over time for different cohorts of participants due to changes in the characteristics of participants, the conservation program itself, and the external environment. For example, the one-year net electricity savings for participants in the Bonneville Power Administration Residential Weatherization Program declined from about 4000 kWh/year for participants in 1981 and 1982 to 2500 kWh for participants in 1983 and 1984. 24 references, 5 figures, 2 tables.

25169 **STORS: Battelle-Northwest's Sludge to Oil Reactor System.** Molton, P.; Fassbender, A.; Brown, M. (Battelle Memorial Institute, Pacific Northwest Div., Richland, WA). pp 272-278 of Municipal treatment plant sludge management. Silver Spring, MD; Hazardous Materials Control Research Institute (1986). (CONF-8605184—).

From National conference on municipal treatment plant sludge management; Orlando, FL, USA (28 May 1986).

A continuous primary sewage sludge thermochemical conversion system was designed, built, and operated for over 100 hr during 1984 at Battelle-Northwest. This was designated as the STORS (Sludge-to-Oil-Reactor System), because the major product was a burnable oil. Starting with 20% solids primary sludge, mixed with 5% by weight of sodium carbonate and heated to 300°C, products obtained included a pourable oil, a char containing most of the inorganic materials, some gas, and an aqueous phase containing dissolved organics and salts. The oil and char under certain conditions separated spontaneously from the aqueous phase.

3209 Education And Public Relations

REFER ALSO TO CITATION(S) 24501, 25000, 25043, 25045, 25046, 25047, 25048, 25062, 25066, 25168

33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

3301 Internal Combustion Engines

REFER ALSO TO CITATION(S) 25247

25170 **(DOE/AL/33183—T1) Multidimensional modeling of convective heat transfer with application to I.C. engines: Technical progress report.** Jennings, M.J.; Morel, T. (Integral Technologies, Inc., Westmont, IL (USA)). 30 Nov 1986. Contract AC04-86AL33183. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002939.

The objective of this project is to develop a more comprehensive understanding of the convective heat transfer process in complex, unsteady turbulent reacting flows, typical of those which occur in internal combustion engines. The specific area of research will be the representation of heat transfer in detailed multi-dimensional Navier-Stokes models, and modeling of turbulent transport mechanisms. The detailed tasks will include a review of relevant prior work. Based on this review, and original work done under this contract, several modeling approaches will be formulated and further studied and tested. The tests will be carried out on flow cases which have relevance to engine flows, and for which reliable experimental data exist. Such data will be sought and identified. The analytical studies will lead to the determination of the best modeling approaches to be used for heat transfer simulation in internal combustion engines. Following that, a detailed study will be carried out of spatial and temporal heat flux distribution in a representative engine. This will be complemented by a parametric study of engine heat transfer dependence on intake flow details, combustion chamber geometry, engine speed and engine load.

25171 **(ORNL/Sub—86-97366/1) A comparison of unburned fuel and aldehyde emissions from a methanol-fueled stratified charge and homogeneous charge engine.** Foster, D.E.; Kim, C.; Scull, N. (Wisconsin Univ., Madison (USA); Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 53p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007793.

This paper presents the results of an experimental program in which a Texaco L-163S engine was fueled with methanol and operated in its traditional stratified charge mode and then modified to run as a homogeneous charge spark ignited engine. The primary data taken were the aldehyde and unburned fuel emissions (UBF). Those data were taken using a continuous time-averaging sampling probe at the exhaust tank and at the exhaust port and with a rotary time-resolving sampling valve located at the exhaust port. The data are for two loads, 138.1 kPa (20 psi) and 207.1 kPa (30 psi) BMEP and three speeds, 1000, 1400 and 1800 rpm. The data indicate that both the stratified charge and the homogeneous charge modes of operation formaldehyde was the only aldehyde detected in the exhaust and it primarily originated in the exhaust and it primarily originated in the cylinder. Over the load and speed ranges tested, the unburned fuel emission were higher and the formaldehyde emission lower when comparing the stratified charge to the homogeneous charge operation. Time resolved data at the exhaust port for the two modes of operation are compared. The homogeneous charge operation had a uniform concentration of both unburned fuel and formaldehyde over the exhaust stroke. The stratified charge data shows large changes in the unburned fuel and moderate changes in the aldehyde concentrations during the exhaust stroke.

25172 **(PB—87-153961/XAB) Advanced material and component technology for gas-fueled prime movers. Appendix B. Topical report, April 1985-May 1986.** Bortz, S.A. (IIT Research Inst., Chicago, IL (USA)). Jun 1986. 81p. (IITRI-M—08260-2). NTIS, PC A05/MF A01.

See also PB—87-15395.

The topical report provides a review of present developments with regard to the status of the adiabatic engine and the rotary engine and work under way to convert these engines to using natural gas as a fuel. The concept centers around insulating the combustion chamber to reduce the heat rejection to the coolant and utilizing the high-energy exhaust gases in an external system such as turbocompounding or cogeneration of steam. The potential for successful developments of the type are high because of the new developments in ceramic-material technology which allow gas-fueled engines to operate at the required high temperatures. Various materials and coatings are reviewed, and their potential for engine use is indicated. Thermal barriers and solid lubricants are examined in relation to their application in a minimum-friction engine. Natural gas is concluded to be a reasonable alternate fuel for the new engine developments.

3303 Electric-powered Systems

REFER ALSO TO CITATION(S) 24965

25173 **(CONF-8610122—9) Lithium-metal sulfide battery development and submodule demonstration.** Chilenskas, A.A.; Biwer, R.L.; DeLuca, W.H. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004819.

From 8. international electric vehicle symposium; Washington, DC, USA (20 Oct 1986).

A program has been initiated by the Electric Power Research Institute to examine the feasibility of using the Li-alloy/FeS battery for electric-vehicle propulsion. In the first phase of the program, a joint effort between Argonne National Laboratory and Gould Research Center resulted in the design, fabrication, and testing of two full-scale 12-V modules and related battery components at Argonne National Battery Test Laboratory. The design of the module and battery components was based upon a van battery design study supported by the US Department of Energy.

25174 **(DOE/NV/10308—H1-Vol.1) ETX-I: First generation single-shaft electric propulsion system program: Volume 1, Powertrain: Final report.** (Ford Motor Co., Dearborn, MI (USA). Research Staff; General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). Feb 1987. Contract AC08-82NV10308. 757p. NTIS, PC A99/MF A01; 1; GPO Dep. File Number DE87008354.

In 1981, discussions between Ford and General Electric (GE) evolved a concept for an advanced electric vehicle powertrain. The concept involved a combination of technology from Ford and GE that would result in a unique powertrain based on a motor and transmission concentric with the drive wheel axis, a concept originally proposed for use with Wankel engines, and based on the use of a "hermetic," three-phase, alternating current (ac) motor, which is currently in high volume production in the necessary horsepower range. An additional benefit of this configuration is the ability to use a single fluid for cooling of the motor and lubrication of the transaxle. This volume describes the powertrain portion of the ETX-I program.

25175 **(DOE/NV/10336—1) Advanced DC Motor Controller: Final report.** (Chrysler Corp., Huntsville, AL (USA). Military-Public Electronic Systems Div.). [1987]. Contract AC08-83NV10336. 277p. NTIS, PC A13. File Number DE87007756.

This report has been prepared to document the work conducted under a Department of Energy contract wherein a high frequency, filtered, DC Motor Controller (DCMC) has been developed which includes facilities for complete electric vehicle systems control. The system features a microprocessor controlled, high frequency, filtered, transistorized motor controller which includes RUN, REGENERATION and CHARGER functions. Also included are all necessary controls and sensors for complete control of an electric vehicle. The unit is totally contained in a 90 pound enclosure. This report details the design and test results of the DCMC system.

25176 **(TVA/OP/EDT—87/17) Test and evaluation of the Technical University of Aachen Range Prediction Device for electrical vehicles: Final report.** Keller, A.S. (Tennessee Valley Authority, Chattanooga (USA). Div. of Energy Demonstrations and Technology). Jan 1987. 150p. NTIS MF A01. File Number DE87900615.

The Technical University of Aachen/Digatron Industrie-Elektronik GmbH Range Prediction Device (RPD) for electric vehicles (EVs) was tested by the Tennessee Valley Authority under the sponsorship of the Electric Power Research Institute. The RPD provides the EV driver with a real-time estimate of remaining vehicle range based on calculations of remaining battery energy and energy consumption rate. RPDs were installed and tested in a Volkswagen Electrotransporter, a South Coast Technology/Volkswagen Rabbit, and a General Motors Griffon van (all with lead-acid batteries). Three different types of tests were used in the RPD evaluation: real world (city and highway driving), 56 km/h (35 mi/h) constant speed, and the SAE J227a C cycle. Range prediction data recorded during the tests were plotted and compared with theoretical values to determine accuracy. Root-mean-square error figures as low as 2.4 and relative errors as low as 0.0% were obtained during the evaluation period.

3304 Hybrid Systems

25177 **(DOE/CE—0179) Electric and Hybrid Vehicles Program: 10th annual report to Congress for Fiscal Year 1986.** (USDOE Assistant Secretary for Conservation and Solar Energy, Washington, DC. Office of Transportation Systems Utilization). Apr 1987. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008350.

This tenth annual report on the implementation of the Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976 (Public Law 94-413, as amended by Public Law 95-238, and Public Law 96-185), referred to as the Act, complies with the reporting requirements established in Section 14 of the Act. In addition to informing Congress of the progress and plans of the Department of Energy Electric and Hybrid Vehicles Program, this report is intended to serve as a communication link between the Department and all of the public and private interests involved in making the program a success. During FY 1986, significant progress was made toward fulfilling the intent of the Congress in the Act. There has been continuing interest shown by both the automobile manufacturing and supply sectors of our economy in electric and hybrid vehicles. Research and development efforts in batteries and propulsion components continue to achieve significant progress in providing industry with technology options that will result in vehicles that will be more economically competitive and more acceptable to the public.

3306 Vehicle Design Factors

25178 **(ORNL/TM—10308) Ceramic technology for advanced heat engines project: Semiannual progress report for April through September 1986.** (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 362p. NTIS, PC A16/MF A01; 1; GPO Dep. File Number DE87008538.

An assessment of needs was completed, and a five-year project plan was developed with extensive input from private industry. Objective is to develop the industrial technology base required for reliable ceramics for application in advanced automotive heat engines. The project approach includes determining the mechanisms controlling reliability, improving processes for fabricating existing ceramics, developing new materials with increased reliability, and testing these materials in simulated engine environments to confirm reliability. Although this is a generic materials project, the focus is on structural ceramics for advanced gas turbine and diesel engines, ceramic bearings and attachments, and ceramic coatings for thermal barrier and wear applications in these engines.

3307 Emission Control

REFER ALSO TO CITATION(S) 25171, 25829

25179 (CONF-8309248—, pp 243-264) **Current understanding of the technical possibilities for reducing pollutant emissions from motor cars.** Apling, A.J. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

Estimates of the pollutant emission performance of the current motorcar fleet and the emission potential of various technology systems for future vehicles are given. The estimates are placed in the context of current understanding concerning the relationship of emission reductions to the effect on the exposure of given targets. The most recent National data for air quality for the US, Japan and Europe is summarised as an indication of the effect of regulation on emissions.

3308 Alternative Fuels

REFER ALSO TO CITATION(S) 24431

25180 **(UCRL—95644) The autoignition of isobutane in a knocking spark ignition engine.** Green, R.M.; Parker, C.D.; Pitz, W.J.; Westbrook, C.K. (Sandia National Labs., Livermore, CA (USA); Jackson State Univ., MS (USA); Lawrence Livermore National Lab., CA (USA)). Nov 1986. Contract W-7405-ENG-48. 41p. (CONF-870204—2). NTIS, PC A03/MF A01; GPO Dep. File Number DE87003241.

From Society of Automotive Engineers international congress and expo; Detroit, MI, USA (23 Feb 1987).

The chemical aspects of the autoignition of isobutane are studied experimentally in a spark ignition engine and theoretically using computer simulations with a detailed chemical kinetic mechanism. The results of these studies show that with the relatively knock-resistant fuel, isobutane, there is a significant amount of fuel breakdown in the end gas with a resulting heat release and temperature increase. The ability of the kinetic model to predict this low temperature chemical activity is assessed and the model is modified to more closely simulate the experimental observations. It is clear that a reasonable degree of low-temperature chemical activity precedes the autoignition event. We address the basic question or whether this first stage of combustion accounts for a chemical preconditioning of the end gas which leads to th autoignition; of whether it merely provides sufficient heat release in the end gas that the high temperature autoignition is initiated.

35 ARMS CONTROL

25181 **(AD-A—176027/1/XAB) COMO (computer modeling systems) integrated air defense (IAD) model evaluation study. Final study report, April-December 1986.** Buescher, D.L. (Army Concepts Analysis Agency, Bethesda, MD (USA)). Dec 1986. 62p. (CAA-SR—86-39). NTIS, PC A04/MF A01.

The purpose of this effort was to evaluate the COMO IAD Model. COMO IAD is a critical-event-stepped, Monte Carlo model suitable for theather simulations of air-to-air, air-to-ground, and ground-to-air combat. The model was installed and exercised for a range of problems in order to identify and rectify any faulty programming steps that might exist, and to gain experience with, an establish confidence in the model. A comparison was made with the more-established and detailed engineering-level COMO model developed by the US Army Missile Command. Results of the comparison indicated, with few exceptions, that the two models will produce similar results under the given scenario.

25182 **(AD-A—176107/1/XAB) Laboratory techniques for determining the effects of pyridostigmine bromide. Interim report, May 1985-May 1986.** Parker, F.R.; Barber, J.A.; Forster, E.M.; Whinnery, J.E. (Rothe Development, Inc., San Antonio, TX (USA)). Nov 1986. 30p. NTIS, PC A03/MF A01.

The USAF Surgeon General approved pyridostigmine bromide (PB) pretreatment for flying personnel as of 21 March 1986. However, specific side effects resulting from taking PB during high sustained + G/sub z/ stress, altitude stress, and periods of potential spatial disorientation had not yet been fully investigated. The USAF school of Aerospace Medicine (UASFSAM), Crew Technology Division, was therefore tasked with this clinical research effort. For effective investigation of these potential problem areas, rapid and accurate methods have had to be established for determining the blood plasma PB levels and the resultant inhibition of acetylcholinesterase activity. The basic purpose of this report is to describe in detail the analytical techniques used at USAFSAM to support the clinical research programs involving the physiological and performance aspects of USAF aircrews taking PB.

3501 Policy, Negotiations, And Legislation

REFER ALSO TO CITATION(S) 24894

3503 Verification

REFER ALSO TO CITATION(S) 24671, 24672

25183 **(UCID—21034) The use of tags in monitoring limits on mobile missiles.** Fetter, S. (Lawrence Livermore National Lab., CA (USA)). Mar 1987. Contract W-7405-ENG-48. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008340.

Three tagging systems were considered in this paper: as a supplement to on-site inspection (OSI), as a supplement to national technical means (NTM), and as a supplement to site surveillance systems. Each system would require a different type of tag, perhaps ranging from microchip tags with infrared transponders to navigation receivers. Use of tags as a supplement to OSIs may be the simplest system to implement because it places the least demands on technology. Tags may make OSI more acceptable by replacing humans with remote sensors, thereby decreasing the perceived potential for espionage. Using tags as a supplement to NTM decreases the necessity for human OSI even further, but places higher demands on technology and may affect the normal operation of deployment areas. Site surveillance systems using tags have the potential for excellent missile verification, but they may be excessively intrusive and expensive, and could have a large effect on the normal operation of declared facilities.

36 MATERIALS

REFER ALSO TO CITATION(S) 24893, 25430, 25481, 25493

25184 **(ORNL/MC—86/2) Technical literature reference guide and professional activities of the Metals and Ceramics Division, April 1, 1986 through June 30, 1986.** Roseberry, F. (comp.). (Oak Ridge National Lab., TN (USA). Metals and Ceramics Div.). Oct 1986. Contract AC05-84OR21400. 40p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007696.

Abstracts are presented of conference presentations and papers in engineering materials, high-temperature materials, materials science, and special projects. (DLC)

25185 **Improved hydrous oxide ion-exchange compound catalysts.** Dosch, R.G.; Stephens, H.P. (to Dept. of Energy). US Patent Application 6-849,913. 9 Apr 1986. 16p. Contract AC04-76DP00789. DE87007228 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007228.

Disclosed is a catalytic material of improved activity which comprises a hydrous, alkali metal or alkaline earth metal or quaternary ammonium titanate, zirconate, niobate, or tantalate, in which the metal or ammonium cations have been exchanged with a catalytically effective quantity of a catalyst metal, and which has been subsequently treated with a solution of a Bronsted acid.

25186 Preparation of catalysts via ion-exchangeable coatings on supports. Dosch, R.G.; Stephens, H.P. (to Dept. of Energy). US Patent Application 6-849,626. 9 Apr 1986. 14p. Contract AC04-76DP00789. DE87007227 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007227.

Disclosed are: new catalytic compositions which comprise an inert support coated with a hydrous alkali metal, alkaline earth metal, or quaternary ammonium titanate, niobate, zirconate, or tantalate, in which the alkali or alkaline earth metal or quaternary ammonium cations have been exchanged for a catalytically effective quantity of a catalytically effective metal.

25187 Ductile polyelectrolyte macromolecule-complexed zinc phosphate conversion crystal pre-coatings and topcoatings embodying a laminate. Sugama, Toshifumi; Kukacka, L.E.; Carciello, N.R. (to Dept. of Energy). US Patent Application 6-795,141. 5 Nov 1985. 22p. Contract AC02-76CH00016. DE87007263 NTIS, PC A02. File Number DE87007263.

This invention relates to a precoat, laminate, and method for ductile coatings on steel and non-ferrous metals which comprises applying a zinc phosphating coating solution modified by a solid polyelectrolyte selected from polyacrylic acid (PAA), polymethacrylic acid (PMA), polyitaconic acid (PIA), and poly-L-glutamic acid. The contacting of the resin with the phosphating solution is made for a period of up to 20 hours at about 80°C. The polyelectrolyte or the precoat is present in about 0.5 to 5.0% by weight of the total precoat composition and after application, the precoat base is dried for up to 5 hours at about 150°C to desiccate. Also, a laminate may be formed where polyurethane (PU) is applied as an elastomeric topcoating or polyfuran resin is applied as a glassy topcoating. It has been found that the use of PAA at a molecular weight of about 2×10^5 gave improved ductility modulus effect.

3601 Metals And Alloys

REFER ALSO TO CITATION(S) 24496, 24584, 24588, 24589, 24632, 24632, 24632, 24644, 24795, 24795, 24797, 24797, 24798, 24798, 24808, 24808, 24817, 24821, 24821, 24850, 24850, 25284, 25320, 25375, 25476, 25819, 26213, 26329

25188 (AD-A—176109/7/XAB) Calorimetric study of the microstructures of a thermomechanically processed al-10.0% mg-0.1% zr alloy. Master's thesis. Andrews, J.N. (Naval Postgraduate School, Monterey, CA (USA)). Sep 1986. 51p. NTIS, PC A04/MF A01.

Differential scanning calorimetry (DSC) was used to investigate microstructure evolution in a high-magnesium aluminum-magnesium alloy, Al-10.0% Mg-0.1% Zr, which had been thermomechanically processed. The two variations of the thermomechanical processing (TMP) investigated resulted in an extremely fine grain size, one of the preconditions for superplastic deformation. The DSC results were consistent with previous research indicating continuous recrystallization occurs during annealing and deformation at relatively low temperatures. Additional insight into the development of the microstructure produced by the two TMP variations was obtained, especially with regard to the intermetallic beta phase. The DSC study also showed that a morphological difference exists in the microstructures produced by the two TMP variations used, and transmission electron microscopy (TEM) results confirmed these differences.

25189 (CONF-860340—16) Martensitic transformation as a deformation process. Olson, G.B.; Cohen, M. (Massachusetts Inst. of Tech., Cambridge (USA)). 1986. Contract FG02-84ER45154. 23p. NTIS, PC A02. File Number DE87007068.

From 115. American Institute of Mining, Metallurgical and Petroleum Engineers annual meeting; New Orleans, LA, USA (2 Mar 1986).

Constitutive relations for transformation plasticity have been derived from martensitic transformation kinetic theory, predicting flow stress as a function of strain, strain rate, temperature, and stress state. The stress-strain curve can exhibit upward curvature under the combined influence of the softening contribution of the transformation as a deformation mechanism and the hardening contribution of the transformation product. This shape provides a maximum stability of plastic flow and quantitatively accounts for observed enhancement of uniform ductility in TRIP (Transformation-Induced Plasticity) steels. In combination with transformation dilatation effects, the flow stabilizing influence also accounts for a major transformation toughening effect observed when ductile fracture is controlled by plastic shear instability. The principles have now been applied to both homogeneous and dispersed-phase alloy systems.

25190 (DOE/ER/45154—T2) Mechanisms of transformation toughening: Progress report, 1 January 1987-31 July 1987. Olson, G.B.; Parks, D.M. (Massachusetts Inst. of Tech., Cambridge (USA)). 1987. Contract FG02-84ER45154. 20p. NTIS, PC A02. File Number DE87007379.

Research is being done on transformation plasticity and toughening in steels and on finite-element modeling of transformation toughening in steels. In the analysis of nonuniform flow and constitutive behavior in TRIP steels, a finite-element analysis was performed to model these steels during simple tension tests. Crack-tip metallographic observations have been performed on the precipitation-hardened 31 Ni steel. Experimental alloys under study are discussed. (DLC)

25191 (ESA-CR(P)—262) Behavior of an Inconel 718 container in the presence of hydrogen. Final report. Azou, P.Y.; Groos, M.; Grenet; Jounier; Wehling. (Ecole Centrale des Arts et Manufactures, 92 - Chatenay-Malabry (France)). Nov 1985. 57p. (In French). (ETN—86-98147). NTIS, PC A04/MF A01.

The properties of the Inconel 718 alloy in the presence of pressurized hydrogen are reviewed. A hydrogen container for space application is studied at different temperatures, determining the hydrogen loss and the fatigue resistance. The study includes a qualification procedure to test permeability and weld quality by the acoustic emission method. The test results indicate that permeability is low, and the mechanical resistance is above twice the utilization pressure.

25192 (LBL—22650) Control of cryogenic intergranular fracture in high-manganese austenitic steels. Strum, M.J. (California Univ., Berkeley (USA). Dept. of Materials Science and Mineral Engineering). Dec 1986. Contract AC03-76SF00098. 130p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87008226.

The sources of cryogenic intergranular embrittlement in high-Mn austenitic steels and the conditions necessary for its control are examined. It is shown that the high-Mn alloys are inherently susceptible to intergranular embrittlement due to both their low grain boundary cohesion and heterogeneous deformation characteristics. Extrinsic sources of embrittlement which could account for the transition behavior are not observed. An Auger electron spectroscopy (AES) study shows no indication of impurity-segregation-induced embrittlement. No grain boundary precipitation is observed, and austenite stabilization does not ensure ductile fracture. The influence of chemistry modifications on the ductile-to-brittle transition behavior were also examined through additions of N, Cr, and C to binary Fe-31 Mn. Nitrogen additions increase the 77K yield strength at a rate of 2200 MPa per weight percent N, and increase the austenite stability, but also increase the susceptibility of ternary alloys to intergranular fracture. Quaternary Cr additions are effective in increasing the N solubility, and lower the transition temperature. Carbon additions result in complete suppression of intergranular fracture at 77K. Qualitatively significant changes in the deformation heterogeneity with chemistry modifications are not observed. The temper-toughening of Fe-Mn-Cr-N alloys is associated with the grain boundary segregation of boron and the redistribution of N. Both boron and carbon are expected to inhibit intergranular fracture through increases in grain boundary cohesion.

25193 (LBL—22879) In situ HREM observation of interphase boundary motion in ^{95}Pb-^{5}Sn solder. Posthill, J.B.; Frear, D.; Morris, J.W. Jr. (Lawrence Berkeley Lab., CA (USA)). Jan 1987. Contract AC03-76SF00098. 6p. (CONF-860829—41). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007616.

From Annual joint meeting of the Electron Microscopy Society of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The micrographs clearly show precipitate dissolution occurring only at the top interface and the tip. These regions of the boundary contain ledges of different sizes. One region contains ledges ~4 nm in height that appear to have rounded corners. Smaller ledges of ~0.6 nm can be seen after further heating in a thinner area of the foil. Their spacing along the boundary is of the order of 8 nm. The lower interface does not appear to contain similar ledges and has not moved during observation. In conclusion, precipitate dissolution has been observed at high-resolution to occur by a ledge mechanism.

25194 (N—87-11873) Grain boundary oxidation and fatigue crack growth at elevated temperatures. Final report. Liu, H.W.; Oshida, Y. (Syracuse Univ., NY (USA)). Oct 1986. 30p. (NASA-CR—179529; NAS—1.26:179529). NTIS, PC A03/MF A01.

Fatigue crack growth rate at elevated temperatures can be accelerated by grain boundary oxidation. Grain boundary oxidation kinetics and the statistical distribution of grain boundary oxide penetration depth were studied. At a constant delta K-level and at a constant test temperature, fatigue crack growth rate, da/dN, is a function of cyclic frequency, nu. A fatigue crack growth model of intermittent micro-ruptures of grain boundary oxide is constructed. The model is consistent with the experimental observations that, in the low frequency region, da/dN is inversely proportional to nu, and fatigue crack growth is intergranular.

25195 (N—87-11889) Mechanical properties of various alloys in hydrogen. Final report. Weeks, N.L.; Mucci, J. (United Technologies Corp., East Hartford, CT (USA)). Jun 1986. 30p. (NASA-CR—178874; NAS—1.26:178874; FR—19269). NTIS, PC A03/MF A01.

Notch tensile tests were conducted to determine the tensile strength of experimental alloys proposed for use in a pressurized gaseous hydrogen environment. The experimental alloys were processed and supplied by the Marshall Space Flight Center. They were supplied in four groups: nickel-base alloys, iron-base alloys, beryllium alloys, and the single-crystal alloy PWA 1480 in seven crystallographic orientations. Testing of the nickel-base, iron-base, and beryllium alloys established the comparative ambient temperature notch tensile strength in 34.5 MPa (5000 psig) gaseous hydrogen environment. After the test results were documented and reported, the test specimens were returned for evaluation. Testing of the single-crystal alloy, PWA 1480, established the notched tensile strength for the various crystallographic orientations in 34.5 MPa (5000 psig) gaseous helium and hydrogen environments at 871 C (1600 F). Strengths established in hydrogen were compared to those in helium to determine environmental degradation due to hydrogen. For the nickel-base alloys, iron-base alloys, and the beryllium alloys, environmental degradation could not be established as no helium environment tests were conducted.

25196 (N—87-12357) Simulation studies for surfaces and materials strength. Semiannual report, 1 May-31 October 1986. Halicioglu, T. (Eloret Corp., Sunnyvale, CA (USA)). Oct 1986. 6p. (NASA-CR—177046; NAS—1.26:177046). NTIS, PC A02/MF A01.

During this reporting period three investigations were carried out. The first area of research concerned the analysis of the structure-energy relationship in small clusters. This study is very closely related to the improvement of the potential energy functions which are suitable and simple enough to be used in atomistic simulation studies. Parameters obtained from ab initio calculations for dimers and trimers of Al were used to estimate energetics and global minimum energy structures of clusters continuing up to 15 Al atoms. The second research topic addressed modeling of the collision process for atoms impinging on surfaces. In this simulation study qualitative aspects of the O atom collision with a graphite surface were analyzed. Four different O/graphite systems were considered and the aftermath of the impact was analyzed. The final area of investigation was related to the simulation of thin amorphous Si films on crystalline Si substrates. Parameters obtained in an earlier study were used to model an exposed amorphous Si surface and an a-Si/c-Si interface. Structural details for various film thicknesses were investigated at an atomistic level.

25197 (NUREG/CR—4724) Fatigue crack growth rates in pressure vessel and piping steels in LWR environments: Final report. Cullen, W.H. (Materials Engineering Associates, Inc., Lanham, MD (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Technology). Mar 1987. 65p. (MEA—2175). NTIS, PC A04/MF A01 - GPO. File Number TI87900563.

The measurement of fatigue crack growth rates for pressure vessel and piping steels in high-temperature, pressurized water has been carried out using compact fracture specimens. Over the last ten years, the programs sponsored by the NRC and carried out at the Naval Research Laboratory and Materials Engineering Associates have provided data for over three hundred tests of these specimens, which have been published in a series of NUREG topical reports and annual reports. This is the final report in this series and describes briefly the significant findings of the program, reports on the most recent data which have been acquired, and indicates some directions for future research in this area.

25198 (ORNL—6354) Corrosion of Fe-25Cr-20Ni alloy in molten alkali carbonates. Hsu, H.S.; Howell, M. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007786.

The Fe-25Cr-20Ni ternary alloy [modified 310 (M310) stainless steel] coated with a 2.0-mg/cm^2 carbonate deposit, (Li/sub 0.62/K/sub 0.38/)$_2$CO$_3$, was exposed to 20% O$_2$-10% CO$_2$-Ar, 0.1% O$_2$-10% CO$_2$-Ar, and 0.35% CO-10% CO$_2$-Ar mixtures with and without the addition of moisture at 650°C. The formation of both liquid (Li,K)$_2$CrO$_4$-saturated (Li,K)$_2$CO$_3$ and LiFeO$_2$ layers on M310 stainless steel provided good corrosion resistance to 20% O$_2$-10% CO$_2$-Ar. On the other hand, the corrosion of M310 stainless steel by 0.1% O$_2$-10% CO$_2$-Ar was severe since no protective scales were formed under this gas environment. In addition, significant internal oxidation of M310 stainless steel might also explain the rapid corrosion reaction by 0.1% O$_2$-10% CO$_2$-Ar. With no moisture in 0.35% CO-10% CO$_2$-Ar, an inner LiCrO$_2$-Cr$_2$O$_3$ layer and an outer mixed-oxide layer formed on M310 stainless steel and provided relatively good corrosion resistance. However, the addition of moisture to the 0.35% CO-10% CO$_2$-Ar caused the formation of porous, nonprotective, and poorly adherent scales. 16 refs., 17 figs., 1 tab.

25199 (PB—87-143806/XAB) Effect of rare-earth elements on the hydrogen-induced cracking in high-strength low-alloy steel. Liu, P.; Si, Z.Y. (Academia Sinica, Shenyang (China). Inst. of Metal Research). 1986. 9p. NTIS, PC PC E03/MF E01.

Effects of rare earth elements (RE) on hydrogen-induced cracking in 15MnV high-strength low-alloy steel (HSLAS) were investigated by using implant tests. It was found that the sensitivity to hydrogen-induced cracking in the HAZ is reduced by adding RE in the steels. This is because RE not only spheroidizes the MnS inclusions but also decreases the diffusible hydrogen content through absorbing hydrogen. The technique of ion-microprobe analysis was adopted to measure the distribution of residual hydrogen in weld and HAZ. The analysis of stress concentration caused by the inclusion in HAZ is based on the elasticity theory. It is proposed that the ratio of rare earth elements to sulphur contents (RE/S) in HSLAS should be controlled within the range of 3 to 6.

25200 (PB—87-143996/XAB) Study on substructures of martensite in steels containing rare earth metals. Chen, B.; Huang, Y.; Wang, X.; Lin, B. (Baotou Inst. of Metals Research (China)). 1986. 8p. NTIS, PC PC E03/MF E01.

Thin foil specimens of Cr-Ni2-Mo-V and Cr-Ni4-Mo-V structural steels and a Fe-0.7C alloy were observed by means of a transmission electron microscope (TEM) in order to explore the influence of misch metal (REM) on the martensitic morphology and tempering process as well as to explain the mechanism of the effect of REM on the increase in toughness of the steels. The experimental results showed that the amount of the twin substructure of the three alloys with REM additions decreased remarkably. It was found that the carbide particles of tempered Cr-Ni2-Mo-V structural steel containing REM become smaller and distributed more uniformly. Thus, all these factors led to the increase in toughness of steel. Results of mechanical property tests showed that REM addition might increase the toughness of steel.

25201 (PB—87-144002/XAB) Rare-earth elements in heat-treatable steels. Zhang, S.; Wu, C. (University of Iron and Steel Technology, Beijing (China). Faculty of Materials). 1986. 15p. NTIS, PC PC E03/MF E01.

Alloying functions of rare earth metals (REM) in iron and steel are discussed. REM have limited solid solubilities in iron, but they strongly tend to segregate to the grain boundaries. They effect phase transformation in steels and also the morphologies of the transformation products. REM have a significant influence on the mechanical properties of steels, particularly on those closely related to the properties of the grain boundaries.

25202 (RAE-TR—5066) Fatigue crack propagation and fracture toughness of plasma arc welded Ti-6Al-4V alloy. Baker, T. S. (Royal Aircraft Establishment, Farnborough (UK)). Jul 1985. 23p. (RAE-MAT/STRUCT—136; BR—98308; ETN—86-98374). NTIS, PC A02/MF A01.

Tensile, fracture toughness, and fatigue crack propagation (FCP) data for a plasma arc weld (PAW) in 4mm thick Ti-6Al-4V alloy sheet were determined. In addition, FCP data for a weld in 9.6mm thick Ti-6Al-4V alloy produced by a PAW root weld and TIG filler runs is reported. In all of the test pieces the stressing direction was normal to the welding direction. Fractures of across-weld test pieces occur in parent metal, the tensile strength of welded sheet is comparable with that of unwelded parent sheet. The fracture toughness of the welds is lower than that of the parent metal due to the hard martensitic microstructure produced in the fusion zone as a result of the high post-weld cooling rates. The FCP rates, for a given delta K, are slower in all the welded test pieces compared with parent material by factors of 5 to 15 for the 4mm thick sheet, and 3 to 7 the 9.6mm thick material.

25203 (SAND—86-0594) PRONTO 2D: A two-dimensional transient solid dynamics program. Taylor, L.M.; Flanagan, D.P. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 225p. NTIS MF A01; 2; GPO Dep. File Number DE87007823.

PRONTO 2D is a two-dimensional transient solid dynamics code for analyzing large deformations of highly nonlinear materials subjected to extremely high strain rates. This Lagrangian finite element program uses an explicit time integration operator to integrate the equations of motion. Four node uniform strain quadrilateral elements are used in the finite element formulation. A number of new numerical algorithms which have been developed for the code are described in this report. An adaptive time step control algorithm is described which greatly improves stability as well as performance in plasticity problems. A robust hourglass control scheme which eliminates hourglass distortions without disturbing the finite element solution is included. All constitutive models in PRONTO are cast in an unrotated configuration defined using the rotation determined from the polar decomposition of the deformation gradient. An accurate incremental algorithm was developed to determine this rotation and is described in detail. A robust contact algorithm was developed which allows for the impact and interaction of deforming contact surfaces of quite general geometry. A number of numerical examples are presented to demonstrate the utility of these algorithms. 41 refs., 51 figs., 5 tabs.

25204 (SAND—86-1299C) Plasma deposition of tungsten. Greenberg, K.E. (Sandia National Labs., Albuquerque, NM (USA)). Dec 1986. Contract AC04-76DP00789. 9p. (CONF-861207—93). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007390.

From Materials Research Society fall meeting; Boston, MA, USA (1 Dec 1986).

Tungsten films were plasma-deposited using an abnormal glow discharge through a mixture of tungsten hexafluoride, hydrogen, and argon. The films adhered well to silicon, silicon dioxide, gallium arsenide, and aluminum substrates placed directly on the discharge cathode. Typical deposition rates were on the order of 160 Angstroms/minute with as-deposited film resistivities of 40 to 70 microohm-cm. The tungsten was analyzed using a number of techniques including x-ray diffraction, scanning electron microscopy, and Auger spectroscopy. Low-resistivity (<10 microohm-cm) films that adhered well to silicon dioxide were obtained with a two-step process utilizing plasma deposition and conventional chemical vapor deposition.

25205 (SAND—86-1849C) In situ friction, wear and electrical contact resistance of precious metal alloys. Pope, L.E.; Peebles, D.E. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 33p. (CONF-870510—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87001423.

From Annual meeting of the American Society of Lubrication Engineers; Anaheim, CA, USA (11 May 1987).

An in situ friction, wear and electrical contact resistance pin-on-plate system has been assembled and installed in a scanning Auger microprobe. Friction coefficients and electrical contact resistance were measured continuously as wear progressed. The surface composition and the topography of a wear track were measured intermittently without exposure of the surface to contaminating environments or removal of the pin from the wear track. Experiments were completed with known and controlled gaseous contaminants in the ambient. For a palladium based alloy pin (ASTM B540) sliding on a gold based alloy plate (ASTM B541), three stages of wear have been identified. The composition of the prow was essentially that of plate material during the first two stages of wear but was a mixture of pin and plate materials during the third stage of wear. In a helium ambient high electrical contact resistance occurred concomitantly with a transition to the third stage of wear.

25206 (SAND—86-2714C) Corrosion sensing with acoustic wave devices. Martin, S.J.; Ricco, A.J.; Sorensen, N.R. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 9p. (CONF-870513—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003516.

From 171. Electrochemical Society meeting; Philadelphia, PA, USA (10 May 1987).

Corrosion of thin metal films has been monitored (real-time) both in gaseous environments and in solution using acoustic wave sensors. A surface acoustic wave (SAW) was used to monitor corrosion in gaseous environments, while a horizontally polarized shear wave (HPSW) allowed measurement in liquid environments. The devices, which have 32 μm transducer periodicity, were fabricated on ST-cut quartz substrates.

25207 (SAND—87-8208) The corrosion of Al 7075-T6 alloy coupled to Ti 6Al-4V in wet air. Mote, M.W. (Sandia National Labs., Livermore, CA (USA)). Mar 1987. Contract AC04-76DR00789. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008347.

Titanium coupled to aluminum alloy 7075-T6 did not accelerate the corrosion of the aluminum in a condensing moist air environment.

25208 Abnormal-glow-discharge deposition of tungsten. Greenberg, K.E. (Sandia National Laboratories, Laser & Atomic Physics Division, P.O. Box 5800, Albuquerque, New Mexico 87185). *Applied Physics Letters;* **50**: No. 16, 1050-1052(20 Apr 1987). Contract AC04-76DP00789.

α-tungsten films that adhere well to silicon dioxide were deposited using a dc abnormal-glow discharge through WF_6, H_2, and Ar. Film resistivities on the order of 30 $\mu\Omega$ cm and deposition rates as high as 200 A/min were obtained without heating the substrate externally. X-ray diffraction, Auger electron spectroscopy, scanning electron microscopy, and transmission electron microscopy measurements indicate that electron scattering at the grain boundaries has limited the conductivity of the plasma-deposited films. Tungsten films having resistivities within a factor of two times that of bulk tungsten were produced with a two-step process utilizing plasma and conventional chemical vapor deposition.

25209 **Structure of Al-Li-Cu icosahedral crystals and Penrose tiling.** Shen, Y.; Poon, S.J.; Dmowski, W.; Egami, T.; Shiflet, G.J. (Department of Physics, University of Virginia, Charlottesville, Virginia 29901). *Physical Review Letters;* **58**: No. 14, 1440-1443(6 Apr 1987).

We report synchrotron x-ray powder-diffraction measurements of the Al-Li-Cu icosahedral phase. Our results are found to be in agreement with the computed diffraction intensities of the three-dimensional Penrose tiling when Al and Cu atoms are randomly positioned at the vertices and edge centers of the unit cells. Comparison is also made with a similarly decorated icosahedral structure constructed by dense packing of icosahedra. The agreement is less satisfactory.

25210 **Superconductivity in high magnetic fields.** Rasolt, M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 and Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Physical Review Letters;* **58**: No. 14, 1482-1485(6 Apr 1987). Contract AC05-84OR21400.

We show that in a donor-doped multivalley semiconductor or multivalley semimetals, at very high magnetic fields, there exists a critical temperature below which a new triplet superconducting phase must arise. This phase is a mirror image of the spin-up, spin-down Cooper-pair condensation where the spins are replaced by the indices of the valleys. Because the magnetic field does not couple to the indices this transition is strongly enhanced in the presence of a magnetic field.

25211 **Low friction and galling resistant coatings and processes for coating.** Johnson, R.N. (to Dept. of Energy, Washington, DC). US Patent 4,649,086. 10 Mar 1987. Filed date 21 Feb 1985. vp.

A coated article of manufacture is described comprising: a substrate selected from the groups consisting of iron base alloys and nickel base alloys; a coating metallurgically bonded to the substrate and having a thickness between 7.5 and 100 microns; the coating formed by the process steps comprising: electro-spark depositing a first material from a cemented carbide electrode consisting essentially of chromium carbide in a matrix selected from the group consisting of nickel and binary nickel-chromium alloys. The matrix forms about 5 to 25 wt.% of the cemented carbide electrode. A layer of the first material is deposited on the substrate and is alloyed therewith; and electro-spark depositing a second material from an electrode selected from the group consisting of aluminium, aluminium alloys containing at least 95 wt.% aluminium, and nickel-molybdenum-chromium alloys containing greater than 20 wt.% molybdenum. A layer of the second material is deposited on the layer of the first material and is alloyed therewith; and the coating formed by the process characterized by a combination of excellent wear resistance and a low average dynamic friction coefficient when in rubbing contact with an identically coated component in a liquid, low oxygen, sodium environment at temperatures below about 650°C.

25212 **Comment on "Limits of the fractal dimension for irreversible kinetic aggregation of gold colloids".** Wilcoxon, J.P.; Martin, J.E.; Schaefer, D.W. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review Letters;* **58**: No. 10, vp(9 Mar 1987). Contract AC04-76DP00789.

A Comment on the Letter by D.A. Weitz et al., Phys. Rev. Lett. 54, 1416(1985).

25213 **Long range ordered alloys modified by addition of niobium and cerium.** Liu, C.T. (to Dept. of Energy, Washington, DC). US Patent 4,647,427. 3 Mar 1987. Filed date 22 Aug 1984. vp.

A long range ordered alloy composition is described consisting essentially of iron, nickel, cobalt, vanadium and a ductility enhancing metal, having the nominal composition (Fe, Ni,Co)/sub 3/(V,M) where M is the ductility enhancing metal selected from the group Ti, Zr, Hf and mixtures thereof. Effective amounts of creep property enhance elements selected from the group cerium, niobium and mixtures thereof sufficient to enhance creep properties in the resulting alloy without adversely affecting the fabrication of the alloy.

25214 **Manufacturing process to reduce large grain growth in zirconium alloys.** Rosecrans, P.M. (to Dept. of Energy, Washington, DC). US Patent 4,647,317. 3 Mar 1987. Filed date 1 Aug 1984. vp.

A method is described of treating cold worked zirconium alloys to reduce large grain growth during thermal treatment above its recrystallization temperature. The method comprises heating the zirconium alloy at a temperature of about 1300°F. to 1350°F. for about 1 to 3 hours subsequent to cold working the zirconium alloy and prior to the thermal treatment at a temperature of between 1450°-1550°F., the thermal treatment temperature being above the recrystallization temperature.

25215 **Ni, Pd, and Pt on GaAs: A comparative study of interfacial structures, compositions, and reacted film morphologies.** Sands, T.; Keramidas, V.G.; Yu, A.J.; Yu, K.; Gronsky, R.; Washburn, J. (Bell Communications Research, Inc., Red Bank, New Jersey 07701-7020). *Journal of Materials Research;* **2**: No. 2, 262-275(Mar 1987).

The reactions between (100) GaAs and the near-noble metals Ni, Pd, and Pt have been investigated by application of high-resolution transmission electron microscopy (TEM), energy-dispersive analysis of x rays in the scanning TEM and Rutherford backscattering spectrometry. Emphasis is placed on the evolution of the phase distributions, film compositions, and interface morphologies during annealing at temperatures up to 480 °C. The first phase in the Ni/GaAs reaction is shown to have the nominal composition Ni_3GaAs. Ternary phases of the type Pd/sub x/GaAs are also found to be the dominant products of the Pd/GaAs reaction. Conversely, only binary phases result from the Pt/GaAs reaction. These observations are used to construct isothermal sections of the M—Ga—As thin-film phase diagrams. The behavior of a thin (1—2 nm) native oxide—hydrocarbon layer during the Ni/GaAs, Pd/GaAs, and Pt/GaAs reactions is also investigated. Only the Ni/GaAs reaction is noticeably impeded in some regions by this intervening layer. In contrast, the Pd/GaAs and Pt/GaAs reactions tend to mechanically disperse the native oxide layers.

25216 **Research needs for corrosion control and prevention in energy conservation systems. I. Problem definition.** Brooman, E.W.; Hurwitch, J.W.; Landgrebe, A.R. (Battelle Columbus Div., OH). *Materials and Society;* **11**: No. 1, 53-64(1987).

About 4% of the GNP in the US is lost each year due to the degradation of materials. About one seventh of this total could be avoided if best available corrosion control and prevention methods were used. Research on improved materials, control and prevention methods, test methodology, experimentation, and data dissemination could lead to an even greater impact on this loss, which in 1982 was estimated to be over $120 billion. A workshop was held to identify some of the research needs for corrosion control and prevention in energy conservation systems. Other objectives were to determine if the Government could play a significant role in coordinating the materials-related research and to prioritize the research needs. In Part I, the problem is defined for selected sectors of the economy. In Part II, research needs are discussed, categorized, and prioritized as to their urgency, impact, potential for successful resolution, and contribution to the existing technology data base. 23 references, 1 table.

25217 **Research needs for corrosion control and prevention in energy conservation systems. II. Identification of needs.** Brooman, E.W.; Hurwitch, J.W.; Landgrebe, A.R. (Battelle Columbus Div., OH). *Materials and Society;* **11**: No. 1, 65-84(1987).

About 4% of the GNP in the US is lost each year due to the degradation of materials. About one seventh of this total could be avoided if best available corrosion control and prevention methods were used. Research on improved materials, control and prevention methods, test methodology, experimentation, and data dissemination could lead to an even greater impact on this loss, which in 1982 was estimated to be over $120 billion. A workshop was held to identify some of the research needs for corrosion control and prevention in energy conservation systems. Other objectives were to determine if the Government could play a significant role in coordinating the materials-related research and to prioritize the research needs. In Part I, the problem is defined for selected sectors of the economy. In Part II, research needs are discussed, categorized, and prioritized as to their urgency, impact, potential for successful resolution, and contribution to the existing technology data base. The findings were used to help formulate the recommendations of the Corrosion Panel of the Committee on Electrochemical Aspects of Energy Conservation and Storage. The latter was organized under the auspices of the National Materials Advisory Board, Commission on Engineering and Technical Systems of the National Research Council. 2 references, 4 tables.

25218 **Fatigue crack propagation behavior in pressure vessel steels for high pressure hydrogen service.** Dauskardt, R.H.; Ritchie, R.O. (Dept. of Materials Science and Mineral Engineering, Univ. of California, Berkeley, CA). pp 17-28 of Properties of high strength steels for high pressure containments. Nisbett, E.G. New York, NY; American Society of Mechanical Engineers (1986). (CONF-860722—).

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

The fatigue crack propagation behavior of heavy-section pressure vessels steels is reviewed, with specific emphasis on alloys commonly utilized for high pressure hydrogen service. Data are presented, for both base plate and weldments, on crack growth in steels exposed to in situ gaseous hydrogen environments, where hydrogen embrittlement is the principal concern, and after prior exposure to high pressure/high temperature hydrogen environments, where hydrogen attack becomes critical. It is shown that at the lower growth rates, where the majority of fatigue life is obtained, the influence of hydrogen on crack growth rates may in certain cases be surprisingly small, a result which appears to originate from the mutually offsetting effects of environmental damage and increased crack tip shielding.

25219 **Solid state welding with an indium interlayer.** Hosking, F.M. (Sandia National Labs., NM). pp 210-212 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Flexible cables are a good example where high temperature processing, such as welding or brazing, cannot be tolerated. The cables are a composite assembly of polyimide, adhesive, and copper layers. Highly reliable, low inductance Cu-Cu connections must be made when placing the cables in service. In some cases, even conventional soldering cannot be used because of either the presence of flux or the sensitivity of the assembly to the soldering temperature. A lower temperature solid state process, however, can make the bond and meet design requirements. In particular, a low temperature Cu-Cu joint can be made with an indium or indium alloy interlayer. The purpose of this study was to evaluate the feasibility of Cu-In-Cu solid state bonds. Oxygen free high conductivity (OFHC) copper and pure indium were used for the evaluation. Bond temperatures were kept below the melting point of In and the Cu-In eutectic. Consequently, the joining process was strictly a solid state process. The bond specimens were cleaned and assembled in an argon glove box. The sample fixture was assembled in the following order: 1. Bottom steel pressing plate; 2. 102 x 127 x 1.6 mm (4 x 5 x 0.063 in.) teflon compression pad; 3. 102 x 127 x 0.05 mm (4 x 5 x 0.002 in.) OFHC Cu coupon; 4. 12.7 x 89 x 0.05 mm (0.5 x 3.5 x 0.002 in.) indium ribbon (six each); the six ribbons were centered lengthwise along the 127 mm (5 in.) length of Cu; 19 mm (0.75 in.) of bare Cu was left at each end for gripping during subsequent peel testing; 5. 102 x 127 x 0.05 mm (4 x 5 x 0.002 in.) OFHC Cu coupon; 6. 102 x 127 x 1.6 mm (4 x 5 x 0.063 in.) teflon compression pad; and 7. Top steel pressing plate.

25220 **Brazing with plated alloys.** Patterson, R.A.; Crane, H.M.; Fox, A.G. (Los Alamos National Lab., NM). pp 202-203 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

The use of braze alloy preforms on complex geometry components is at times a very difficult task requiring extensive handling of the parts or even tack welding of the preform to ensure that it is held in place. One method of overcoming these difficulties is the use of plated braze alloys (i.e., filler metals) applied directly to the braze region. Plating helps to avoid the potential for contamination resulting from handling and also ensures that the braze alloy is located properly. Examples are discussed in which an electroplated silver-copper alloy is used as an alternative to the BAg8 preforms and electroless nickel is used as a replacement for an amorphous Ni-P braze alloy foil. A toroidal cooling plate with helical flow channels was fabricated from oxygen-free high conductivity (OFHC) and brazed using the electroplated silver-copper alloy. The silver-copper braze alloy was applied to the copper substrate in a laminated fashion of alternating layers of silver and copper, which in combination approximated the eutectic composition (72% Ag-28% Cu by weight). Examination of the brazed assemblies indicated that in both cases the advantages of using plated braze alloys are numerous. These advantages include decreased labor, improved cleanliness and exactness of braze alloy placement. The primary disadvantage was an increased tendency for solidification defects presumably resulting from contaminants in the plating baths. This last observation is presently being examined in greater detail. The end results is that the assemblies brazed with the plated alloys were acceptable for the intended application and that the use of plating facilitated the successful assembly of these components.

25221 **Fracture toughness of A286 stainless steel brazements.** Spingarn, J.R. (Sandia National Labs., NM). pp 200-201 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Determining the appropriate design rules for solders and brazes requires understanding both the strength and fracture toughness of the joint region. While the need for strength information is evident, and a considerable literature exists, fracture toughness data are sparse. Mostly Charpy impact toughness is reported, which is of limited value to the designer. Nonetheless, fracture toughness data are required to properly calculate the load-carrying capability of any structure containing flaws or other stress singularities. In a brazed joint these stress singularities can arise in two ways. First, all brazed joints contain discontinuities, including voids, microcracks and regions with no wetting. In some materials, glasses and ceramics being excellent examples, strength calculations seriously underestimate the deleterious effect of flaws. Second, in layered structures like brazed joints, even in the absence of flaws, discontinuities in physical properties (elastic modulus, Poisson's ratio) induce stress singularities which are similar to crack-like discontinuities. The only way to evaluate the significance of these two factors is to perform experimental measurements. The goals of the program to be described in this presentation are to measure the fracture toughness of prototypical brazements under a variety of loading conditions and to measure the fracture toughness as a function of fabrication practice, i.e., braze gap, and thus optimize toughness when the loading conditions are uncertain.

25222 **A hot cracking test for thin sheet - The sigmajig.** Goodwin, G.M. (Oak Ridge National Lab., TN). pp 162-163 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Studies of the hot cracking behavior of austenitic stainless steels and other alloys represent a significant portion of to-day's welding technical literature. In the mid-to-late 1960's, the Varestraint and Tigamajig were introduced, and are currently the most utilized weldability tests for hot cracking. Neither of these tests, however, can be used on material less than roughly 3 mm (0.12 in.) thick. The three currently existing thin sheet test are useful. However, they rely on self-imposed restraint and thus are limited in their degree of discrimination. The Sigmajig was developed to meet the usual criteria for a hot cracking test, i.e., to be reproducible, sensitive to test and welding variables, economical, and applicable to more than one welding process, and in addition, to be usable on thin sheet, and to have variable loading capacity severe enough to crack materials which pass the other tests.

25223 **Electron beam welding of heavy section 3Cr-1.5Mo alloy.** King, J.F.; David, S.A.; Nasreldin, A. (Oak Ridge National Lab., TN). pp 152-153 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Welding of thick section steels is a common practice in the fabrication of pressure vessels for energy systems. The fabrication cost is strongly influenced by the speed at which these large components can be welded. Conventional welding processes such as shielded metal arc (SMA) and submerged arc (SA) are time-consuming and expensive. Hence there is a great need to reduce welding time and the tonnage of weld metal deposited. Electron beam welding (EBW) is a process that potentially could be used to achieve dramatic reduction in the welding time and costs. The penetrating ability of the beam produces welds with high depth-to-width ratios at relatively high travel speeds, making it possible to weld thick sections with one or two passes without filler metals and other consumables. The paper describes a study that was undertaken to investigate the feasibility of using a high power electron beam welding machine to weld heavy section steel. The main emphasis of this work was concentrated on determining the mechanical properties of the resulting weldment, characterizing the microstructure of the various weldment regions, and comparing these results with those from other processes. One of the steels selected for the heavy section electron beam welding study was a new 3 Cr-1.5 Mo-0.1 V alloy. The steel was developed at the AMAX Materials Research Center by Wada and co-workers for high temperature, high pressure hydrogen service as a possible improved replacement for 2-1/4 Cr-1 Mo steels. The excellent strength and toughness of this steel make it a promising candidate for future pressure vessels such as those for coal gasifiers. The work was conducted on 102 mm (4 in.) thick plates of this material in the normalized-and-tempered condition.

25224 **Welding and brazing the Westinghouse fusion magnet coil.** Fetzko, R. (Westinghouse Electric Corp.). pp 148 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Westinghouse Electric Corporation recently completed the construction of a test magnet coil as part of the Large Coil Program (LCP), funded by the U.S. Department of Energy (DOE) and managed by the Oak Ridge National Laboratory (ORNL). The superconducting magnet will ultimately be tested at its anticipated service temperature of -450°F (-268°C) as part of DOE's research efforts with fusion power. The production metals joining required to construct the magnet are discussed. This includes reasons for process selection, joining procedures and techniques, acceptance testing, and production experiences. Because the magnet design was of a continuous wound, pancake construction, the niobium-tin superconducting cable had to be joined as a series connection. The series connections were made with an 800 A resistance butt joint welding unit which was modified to access the connections. Zero defects was the acceptance criteria for the connections as verified by dye penetrant and 100% X-ray inspection. The main electrical leads required a two step brazing sequence. A stainless steel sleeve was first brazed to the copper lead in a vacuum furnace with a copper/gold alloy at 1800°F (982°C). The superconducting cable was subsequently brazed into the copper lead with induction heating at 1300°F (704°F).

25225 **Fusion welding of structural materials for 4 K service.** Dalder, E.N.C. (Lawrence Livermore National Lab.). pp 144-147 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Many needs for fusion welding cryogenic materials relate to the design and construction of high field superconducting magnets that operate at temperatures of 4 K (-452°F) or below. Three distinct types of materials are used in these magnets: superconducting wire to carry the current that creates the field, high-strength structural alloys to position and support the superconductor, and electrical insulators to separate the wires from one another. There are important problems with each of these material types, but the present paper focuses on fusion welding issues related to the structural alloys. The United States Department of Energy currently supports research on two basic concepts for magnetic fusion energy; these are toroidal confinement and mirror confinement, which differ in the way the cylindrical plasma is bounded along its length. Both use a high magnetic field to heat and compress the plasma into a cylinder. Both must employ superconducting magnets to create that field if magnetic fusion energy is to be technically feasible or commercially viable. The increasingly stringent specifications for magnet structural alloys and their welds results from the increasing size and field of the magnets, both of which raise the mechanical load on the magnet structure. While the systems that are now under construction have been designed with existing alloys, future design require alloys that offer superior combination of strength and toughness at 4 K.

25226 **Solidification and solid-state transformations of high energy density austenitic stainless steel welds.** Brooks, J.A.; Baskes, M.I.; Greulich, F.A. (Sandia National Labs.). pp 139-140 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Much work has been undertaken in studying the solidification and solid-state transformations of austenitic stainless steel welds. Considerable confusion existed as to both the solidification mechanics and solid-state transformations which lead to a wide range of ferrite morphologies. It has been found that both the primary phase of solidification and the ferrite morphologies are controlled primarily by the Cr/Ni ratio. The application of analytical electron microscopy was very beneficial in leading to a clearer understanding of the microstructural evolution of the rather complex weld structures. In the investigations, the authors are studying the solidification behavior and solid-state transformations of high energy density welds (electron beam and laser) and comparing these to GTA welds. Fe-Ni-CR ternary alloys covering a range of Cr/Ni ratios typical of those of the AISI 300 series alloys are being investigated. Extensive analysis including electron microprobe, TEM, and STEM (scanning transmission electron microscopy) analytical microscopy were used to characterize GTA welds which solidified both as primary ferrite and primary austenite and exhibited, when welded, a wide range in ferrite morphologies. Solidification modeling of microsegregation of the welds was also conducted. The model incorporates three dimensional finite difference analysis, solute partitioning between the liquid and solid, and solid-state diffusion in the three components system. The results of the modeling were extremely valuable in leading to an understanding of the effect of solidification microsegregation on both the measured microsegregation and solid-state transformations.

25227 **Ferrite stability in duplex austenitic stainless steel welds.** Vitek, J.M.; David, S.A. (Oak Ridge National Lab.). pp 136-137 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

The presence of ferrite in austenitic stainless steel welds is known to be beneficial in avoiding hot cracking problems. In particular, the primary delta ferrite mode of solidification is important.

For alloy compositions in which primary ferrite forms, it has been shown that up to approximately 40% ferrite may exist in the as-solidified structures. With further cooling, the ferrite becomes unstable, transforming to austenite. However, under typical welding conditions, the cooling rate is sufficiently high to suppress the complete transformation of ferrite and some residual ferrite is retained. For example, for Type 308 austenitic stainless steel filler metal, gas-tungsten arc welds contain 6 to 10% ferrite, although under equilibrium conditions at elevated temperatures, this same alloy can be homogenized into a fully austenitic structure. Thus, it is clear the retained ferrite in such duplex structure welds is unstable and transforms during elevated temperature applications. The stability of ferrite was investigated by measuring its composition after several different thermal treatments. The composition was measured by means of analytical electron microscopy of thinned foils, and only the major constituents, iron, chromium, and nickel, were analyzed. The composition of ferrite was measured as a function of aging time and temperature. It was found that, during aging, the ferrite composition changes and approaches a metastable equilibrium limit before eventually transforming to sigma phase or austenite. This limiting composition was determined as a function of temperature.

25228 Video monitoring of gas tungsten arc welds. Marburger, S.J. (Sandia National Labs.). pp 122-124 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

This presentation details an arc viewing system used to observe gas tungsten arc (GTA) welds being made on prototype parts and fixturing where visual access is limited by part geometry or because welding is being done in a glove box. Full color images produced by the system are sufficient in both size and detail to allow welding operators to monitor and control weld deposition. Video signals produced by the weld arc monitor may be recorded for later playback. Tapes thus produced have proven useful in operator training and quality control. The fundamental limitations in GTA viewing are discussed in detail along with practical solutions to the problems. Optical considerations such as image magnification and depth of field, fiber optic/video detector interactions, video and film dynamic range, contamination of optics by welding fume, and optical fixturing are important inputs when designing the optical system.

25229 Energy, temperature and deformation behavior during tubular inertia welding. Knorovsky, G.A.; Mc Vey, D.F.; Jellison, J.L.; Henning, R.G. (Sandia National Labs.). pp 63-64 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

In order to substitute 4330V steel for a large portion of a component originally manufactured from HP 9-4-20 steel, and to thus effect a considerable cost and strategic material savings, a transition joint between 4330V and HP 9-4-20 steel was developed. Since cost reduction was important as a strategic material conservation measure, a process that would be quick, reliable, and cost effective was desired. Inertia welding was chosen as a likely candidate process. Consequently, this study was initiated to better understand the inertia welding process and thus place us in a better position to specify a weld schedule which would provide acceptable quality and mechanical properties. The authors have previously reported on the measurement of mechanical properties of the welds produced according to a statistically designed experiment. In this paper they will discuss diagnostic experiments on the inertia welding process, itself. Diagnostic techniques included high speed video recording, thermocouples, elastic strain gauges, and measurement of plastic upset after welding. The high speed video records allowed measurement of rotational speeds and accelerations, which through the equations of motion and energy conservation, allowed determination of energy dissipation during the weld process. They also allowed measurement of upset during inertia welding. Using the data on energy dissipation and upset obtained from the video records, and thermocouple measurements, an analytic heat flow balance, taking into account advection, conduction, and convection was carried out. This made it possible to predict thermal histories as a function of distance from the weld interface. Statistical analysis allowed quantitative assessment of the effects of the welding parameters: flywheel moment of inertia, axial pressure, and kinetic energy stored in the flywheel, on the resulting final upset.

25230 Effect of sulfur on weld geometry in pulsed laser welds. Jellison, J.L. (Sandia National Labs.). pp 42-44 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

The primary goal of the present study was to determine whether compositional differences in a surface active element in austenitic stainless steel can alter the geometry of pulsed laser welds. Clearly, much less time is available during pulse laser welding for convection cells to form and influence heat transfer. A two-dimensional heat-transfer code has been developed for pulsed Nd:YAG laser welding that only incorporates heat transfer by conduction for the molten metal. For fluences that do not result in significant evaporation, this code generally yields good predictions of weld geometries, if appropriate corrections are made for surface absorptivity. At higher fluences, significant differences are found between predicted and observed weld pool shapes. This study is a portion of a larger program to determine the causes of these differences. Earlier work has produced direct experimental evidence that convection cells can develop during pulsed laser welding. However, experimental evidence that convection is present during welding is not sufficient to indicate whether convection is a dominant heat transfer mechanism. More recently, modeling of transient two-dimensional Marangoni flow in a pulsed laser weld pool was attempted.

25231 Experimental study on impact/fretting wear in heat exchanger tubes. Cha, J.H.; Wambsganss, M.W.; Jendrzejczyk, J.A. New York, NY; American Society of Mechanical Engineers (1986). 12p. (CONF-860722—). American Society of Mechanical Engineers, 345 East 47 St., New York, NY 10017.

From ASME pressure vessel and piping conference and exhibit; Chicago, IL, USA (20 Jul 1986).

The objective of this study is to provide qualitative impact/fretting wear information for heat exchanger tubes through the performance of a series of tests involving the pertinent parameters: force between the tube and its support; tube to support plate hole clearance; tube support plate thickness; preload; and tube vibration frequency. The characteristics of impact/fretting wear relative to material combinations and fluid environment were also investigated. The test apparatus consists of a cantilevered tube with a simulated tube support plate at the "free end". Tube vibration is induced by an electromagnetic exciter to simulate the flow-induced tube motion occurring in a real heat exchanger at the tube/tube support plate interface. Tests are conducted in air, water, and oil, all at room temperature. Removable wear rings are attached to the tube free end and simulated support fixture. Wear ring materials include carbon steel, 304 stainless steel, Inconel 600 and brass. Wear is measured by a weight loss technique and wear rates are calculated and reported as functions of the various pertinent parameters. Based on the test results, general conclusions are drawn.

25232 Thermodynamic and kinetic aspects of the crystal to glass transformation in metallic materials. Johnson, W.L. (California Institute of Technology, Pasadena). *Progress in Materials Science;* **30**: No. 2, 81-134(1986). Contract FG03-86ER45242.

The present article systematically surveys and reviews the subject of crystal to glass transformations. The variety of circumstances under which such transformations have been observed raises the need for a unifying conceptual basis for understanding why crystalline solids become unstable with respect to vitrification. Using basic principles of thermodynamics and kinetics, one can formulate the problem of amorphization in the language of the theory of melting. A study of the fundamental thermodynamic and kinetic aspects of this problem leads to the general notion of an ultimate limit of stability of a crystalline solid with respect to various types of disorder. Increasing a particular type of disorder in a crystal leads first to metastability and finally to instability. An attempt will be made to develop a basis for understanding the onset of such instability as driven by various types of disordering processes. It will be seen that a wide variety of observations can be understood using a relatively small number of simple concepts. Finally, the article points out some common features which underlie the formation of amorphous phases during the evolution of non-equilibrium systems. 152 references, 27 figures, 3 tables.

25233 Susceptibility of Inconel X-750 to stress corrosion cracking. Mishra, B. Minneapolis, MN; Univ. of Minnesota (1986). 169p. University Microfilms Order No. 86-27,029.

Thesis (Ph. D.).

High strength, age hardenable Ni-base superalloy Inconel X-750 in susceptible to severe intergranular stress corrosion cracking (IGSCC) when used in the triple heat treated condition. In this research, constant strain rate technique was employed to evaluate the stress corrosion cracking susceptibility of alloy X-750 under simulated pressurized water reactor conditions in a nuclear power plant using an automated autoclave system at 8×10^6 N/m^2 pressure and 289°C temperature. The alloy produced via ESR and VAR processing routes containing .004% and .011% sulfur, respectively, were solution annealed at 1075 and 1240°C for 2 hours and water quenched followed by aging in the 704 to 871°C temperature range up to 200 hours and cooled in air as well as the furnace. Complete grain boundary chemistry and precipitation morphology was studied, supported by observations made using Charpy impact and modified Huey tests. Results showed Inconel X-750 processed through electroslag refining, solution annealed at 1240°C for 2 hours and water quenched followed by aging at 871°C for 200 hours and furnace cooling, provides the best combination of strength, ductility, and resistance to SCC.

25234 Method for welding chromium molybdenum steels. Sikka, V.K. (to Dept. of Energy). US Patent Application 6-795,605. 6 Nov 1985. 14p. Contract AC05-84OR21400. DE87007267 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007267.

Chromium-molybdenum steels exhibit a weakening after welding in an area adjacent to the weld. This invention is an improved method for welding to eliminate the weakness by subjecting normalized steel to a partial temper prior to welding and subsequently fully tempering the welded article for optimum strength and ductility.

25235 Refraction and diffraction of photoelectrons at the Ge(001) surface. Miller, T.; Shapiro, A.P.; Chiang, T.C. (Univ. of Illinois, Urbana). *Physical Review [Section] B: Solid State;* **31**: No. 12, 7915-7918(15 Jun 1985). Contract AC02-76ER01198.

High-resolution photoemission spectra for the Ge 3d core levels were measured as a function of the polar emission angle from the Ge(001) surface for k along either the Ge[010] or the Ge[110] azimuth. The spectra were deconvolved to yield the separate contributions from the surface atomic layer and the bulk. Both sets of data show a general increasing trend for the surface contribution relative to the bulk contribution for increasing polar emission angle; superimposed on the increasing trend are small aperiodic oscillatory variations due to diffraction. The data were analyzed by ignoring diffraction. Refraction was found to be important; from a theoretical fit to the data, they obtained a value of 15 eV for the crystal inner potential relative to the vacuum level and a value of 7.2 A for the electron escape depth at an electron kinetic energy of 37 eV.

25236 Theory of the aluminum shock equation of state to 10^4 Mbar. Young, D.A.; Wolford, J.K.; Rogers, F.J.; Holian, K.S. (Lawrence Livermore National Lab., CA). *Physics Letters [Section] A;* **108A**: No. 3, 157-160(25 Mar 1985). Contract W-7405-ENG-48.

A composite theoretical shock equation of state for aluminum is compared with experimental data, including new Soviet data to 4000 Mbar. Overall agreement is good, showing the current theoretical models of hot, dense matter are adequate. Significant electron shell structure effects are predicted by ionization equilibrium and self-consistent field models to occur in the 1000 Mbar region, but better experimental precision is needed for testing the models here.

25237 Inelastic analysis of a hot spot on a heavy vessel wall. Baumert, K.L.; Secrist, D.A. (Air Products and Chemicals, Inc., Allentown, PA). pp 287-298 of Analyzing failures: The problems and the solutions. Goel, V.S. Metals Park, OH; American Society for Metals (1985). (CONF-851203—).

From International conference and exhibition on fatigue, corrosion cracking, fracture mechanic and failure analysis; Salt Lake City, UT, USA (2 Dec 1985).

Heavy wall, 0.2-0.3 m (8-12 inches), reactor vessels are common in the refining process industries. Many of these vessels are used in process operations involving hydrogen at high pressures and temperatures. When processing conditions involve three-phase flow, maintaining a uniform temperature distribution in the vessel becomes a concern. Maldistributed flow can result in a hot spot on the vessel wall. This hot spot condition was simulated by computer analysis on a reactor vessel with a 0.25 m (10-inch) thick wall. The results indicate that stresses are relieved after a short period of time (1000-3000 hours) because of metal creep. The bulge on the ID is small and probably within the original vessel tolerance. Very high residual stresses are imparted to the steel after cooldown. This could result in a fatigue failure because of normal startups and shutdowns. Finally, if the vessel is fabricated from heat treated steel, the elevated temperature can temper the alloy to below minimum design properties.

25238 Microstructure and topography of vapor deposited, sputtered and annealed (111) palladium films. Dixit, P.; Vook, R.W. (Syracuse Univ., NY). *Applications of Surface Science;* 1-12(1985). Contract AC02-83ER45034.

The microstructural effects of argon ion bombardment and thermal annealing on vapor deposited (111) Pd films on mica substrates have been studied. Sputtering resulted in surface roughening as well as in the formation of an amorphous phase and double positioned twins. In the higher fluence zones, relatively large blisters were formed. Moderate annealing of the sputtered film did not restore the original smoothness of the surface. The hillocks became larger while their density decreased. 4 references, 12 figures.

25239 Application of HVEM in phase: transformation research. Westmacott, K.H.; Dahmen, U. (Lawrence Berkeley Lab., CA). *Materials Science Forum;* **3**: 325-334(1985). Contract AC03-76SF00098.

In a high voltage electron microscope, relatively thick sections can be penetrated with the consequence that in hot stage experiments the foil surfaces are no longer the dominant sink for solute atoms and point defects. This allows dynamic changes in microstructure, representative of bulk materials, to be studied in-situ. In this paper, several examples are given that illustrate the utility of this procedure in studies of precipitation reactions and other phase transitions. The technique has been particularly useful in correlating the nucleation or growth or a new phase with changes in the lattice defect structure. In several instances, credible nucleation and growth mechanisms have been deduced from the observations. 18 references, 5 figures.

25240 Deposition of selenium coatings on beryllium foils. Erikson, E.D.; Tassano, P.L.; Reiss, R.H.; Griggs, G.E. (Lawrence Livermore National Lab., CA). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **A236**: 533-535(1985). Contract W-7405-ENG-48.

A technique for preparing selenium films on 50.8-μm thick beryllium foils is described. The selenium was deposited in vacuum from a resistance heated evaporation source. A water-cooled enclosure was used to minimize contamination of the vacuum system and to reduce the exposure of personnel to toxic and noxious materials. Profilometry measurements of the coatings indicated selenium thicknesses of 5.5, 12.9, 37.5, 49.8 and 74.5 μm. The control of deposition rate and of coating thickness was facilitated using a commercially available closed-loop programmable deposition controller. The X-ray transmission of the coated substrates was measured using a tritiated zirconium source. The transmissivities of the film/substrate combination are presented for the range of energies from 4 to 20 keV.

25241 **Critical assessment of low-fluence irradiation creep mechanisms.** Henager, C.H. Jr.; Simonen, E.P. (Pacific Northwest Lab., Richland, WA). *American Society for Testing and Materials, Special Technical Publication;* 75-97(1985). Contract AC06-76RL01830.

A climb-controlled guide (CCG) creep model, which has been used to successfully rationalize low-fluence, light-ion irradiation creep data in pure nickel, accounted for low-fluence irradiation creep rates and loop growth rates in Type 316 stainless steel. The model also predicted a weak stress dependence and a weak temperature dependence in agreement with typical observations. Both light-ion and neutron irradiation creep measurements and microstructural observations at low fluences were examined and compared with predictions of the CCG model. Calculated creep rates compared to measured creep rates demonstrated that dislocation glide was the dominant mode of deformation during low-fluence creep when interstitial loops were small. When the interstitial loop radius approached one half the average dislocation glide distance, the dislocation glide contribution was small. The stress-induced preferred absorption (SIPA) creep mechanism contributed an increasing fraction of the total deformation as the loop radius increased and became dominant at fluences greater than 1 displacement per atom (dpa). The CCG creep model assumes that glissile network dislocations intersect the small dislocation loop glide barriers, climb into a favorable orientation, and annihilate the loop through a Burgers vector reaction. Dislocation climb controls the rate of loop annihilation that allows dislocation glide between loop barriers. The creep rate is determined by a balance between irradiation-enhanced dislocation climb and interstitial loop growth. 20 references, 13 figures, 2 tables.

25242 **Inhomogeneous strains in small particles.** Marks, L.D. (Arizona State Univ., Tempe). *Surface Science;* **150**: 302-318(1985). Contract AC02-76ER02995.

This paper considers the evidence for strains in small particles. Firstly, the dynamical electron diffraction theory for dark field imaging of small particles is briefly reviewed, considering primarily the effects of strain on wedge crystals and identifying the fingerprint of strain contrast effects under strong beam conditions. Evidence included herein and from published papers by other authors clearly shows inhomogeneous strain effects in both multiply twinned particles and single crystals. Considering these results and earlier reports of lattice parameter changes, there are problems with the uniqueness of these analyses, and the strains in the small single crystals are thought more likely to be due to interfacial stresses or contaminants than any intrinsic particle effect; there are so many different origins of this type of strain that the authors cannot with confidence isolate a unique source. It is emphasized that the uniqueness of any interpretation of experimental results from small particles must be very carefully considered. 90 references, 9 figures.

25243 **Performance of multilayer dispersion elements from 80 to 500 eV.** Bartlett, R.J.; Kania, D.R.; Trela, W.J.; Kaellne, E.; Lee, P.; Spiller, E. (Los Alamos National Lab., NM). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **447**: 23-26(1984).

The authors have measured the reflectivity of several multilayer dispersion elements between 80 and 500 eV. Two samples of ReW-C and one of Ni-C with 2d spacing of approximately 70 A and 150 A were tested at angles of incidence between 10° and 80°. Measurements were made by fixing the incident and reflected angles (Bragg) and scanning the photon energy. Theoretical analyses of these multilayers have also been made and the results are compared with the experimental measurements. 4 references, 1 figure, 1 table.

25244 **Comparison of predicted versus experimental stress for initiation of crack growth in specimens containing surface cracks.** Reuter, W.G. (EG and G Idaho, Inc., Idaho Falls, ID 83415). pp 644-660 of Fracture mechanics: Seventeenth volume. Philadelphia, PA; ASTM (1984). (CONF-8408200—).

From 17. ASTM Committee E-24 national symposium on fracture mechanics; Albany, NY, USA (7 Aug 1984).

Fracture mechanics concepts were used to evaluate the ability to predict the stress for crack initiation for specimens containing surface cracks. The comparison is made between the predicted stress (σ/sub pred/) and the experimentally determined stress (σ/sub exp/). The predictions were made for conditions ranging from elastic to plastic. The predictions were based on suggestions for modifying an equation developed for center-cracked panels. Acoustic emission techniques were used to detect the load corresponding to crack initiation.

25245 **Nucleation and growth characteristics of crystalline deposits on amorphous substrates.** Inal, O.T.; Gundiler, I.H. (New Mexico Institute of Mining and Technology, Socorro). *Thin Solid Films;* **112**: 149-159(1984).

Electrodeposited and vapor-deposited platinum and chromium overgrowths on amorphous and crystallized $Fe_{80}B_{20}$ field emission end forms are seen to consist of a three-layer arrangement of an epitaxial or pseudomorphic initial layer followed by a zone of misfit which is covered by the polycrystalline form of the overgrowths. This is similar to crystalline substrate/crystalline overgrowth systems previously observed following depositions through vacuum evaporation, electrodeposition and cementation onto field ion microscope tips. Although the distinct three-layer arrangement is easy to discern using crystallized $Fe_{80}B_{20}$ end forms for both platinum and chromium overgrowths, it is much more difficult to distinguish the amorphous substrate from the initial layer and the zone of misfit. The topmost polycrystalline form, however, is quite easy to discern. The amenability of these systems to field ion microscopy imaging, in a neon atmosphere at 78 K, indicates that the overgrowths are well attached to the corresponding substrates.

25246 **Theoretical high-pressure equations of state and phase diagrams of the alkali metals.** Young, D.A.; Ross, M. (Lawrence Livermore National Lab., CA). *Journal of Non-Crystalline Solids;* **61-62**: 119-122(1984). Contract W-7405-ENG-48.

A two-parameter Heine-Abarenkov local pseudopotential has been fitted to experimental solid isotherms of Li, Na, and K to 100 kbar pressure. A one-component plasma fluid variational theory is then used with the fitted potentials to compute alkali metal liquid isotherms, Hugoniots, and melting curves. Agreement between theory and experiment is good. 13 references, 4 figures.

3602 Ceramics, Cermets, And Refractories

REFER ALSO TO CITATION(S) 24590, 24731, 24732, 25178, 25196, 25457, 25476, 25494, 26329

25247 **(AD-A—176137/8/XAB) Protective oxides formed on CoCrAlY (cobalt, chromium, aluminum and yttrium) coatings. Interim report, 1 October 1985-1 April 1986.** Aprigliano, L.F. (David W. Taylor Naval Ship Research and Development Center, Annapolis, MD (USA). Ship Materials Engineering Dept.). Nov 1986. 32p. (DTNSRDC/SME—86/52). NTIS, PC A03/MF A01.

The metallic coatings used to protect the hot-section turbine blades of marine gas turbines are often a mixture of cobalt, chromium, aluminum, and yttrium (CoCrA1Y). Using the surface-sensitive technique of x-ray photoelectron spectroscopy, the protective oxide scales on CoCrA1Y coatings containing nominal levels of 20, 29, and 35wt% chromium were found to be essentially the same and were predominantely alumina and a yttrium rich phase that is tentatively identified as yttrium aluminum garnet. As increasing levels of chromium in this coating system are known to improve the coating's hot corrosion resistance, the similarity of the initial scales on all these coatings leads to the conclusion that chromium provides its hot corrosion benefit by slowing the propagation phase of the bulk coating attack.

25248 (AD-A—176215/2/XAB) **Preparation and characterization of members of the chromium-zirconium oxide system. Technical report.** Wu, P.; Kershaw, R.; Dwight, K.; Wold, A. (Brown Univ., Providence, RI (USA). Dept. of Chemistry). 13 Jan 1987. 19p. (TR—2). NTIS, PC A02/MF A01.

Samples of zirconium oxide containing 5-20 atomic percent chromium were prepared by double decomposition of the nitrates. X-ray-diffraction analysis showed the products to be single phase. Magnetic suspectibility measurements were used to characterize the formal oxidation state of the chromium.

25249 (CONF-861111—22) **Magnetic moments of Co substituted $Y_2Fe_{14}B$.** Gu, Zong-Quan; Ching, W.Y. (Missouri Univ., Kansas City (USA). Dept. of Physics). 1986. Contract FG02-84ER45170. 10p. NTIS MF A01; 2; GPO Dep. File Number DE87008026.

From Conference on magnetism and magnetic materials; Baltimore, MD, USA (17 Nov 1986).

The local spin magnetic moments at each of the six inequivalent Fe sites in $Y_2Fe_{14}B$ crystal are studied as the Fe atoms are selectively substituted by Co. First-principles Spin-polarized electronic structure calculations are performed by the orthogonalized LCAO method and the spin magnetic moments are deduced from the site-projected and spin-projected partial density of states. In general, a Co substituted site has a smaller moment than the same site in $Y_2CO_{14}B$. The unsubstituted Fe sites are almost unchanged. The c, j_2 and j_1 sites are affected most while the e site is least affected by the Co substitution.

25250 (CONF-861111—23) **Electronic structure of $Nd_2Fe_{14}B$.** Ching, W.Y.; Gu, Zong-Quan. (Missouri Univ., Kansas City (USA). Dept. of Physics). 1986. Contract FG02-84ER45170. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008027.

From Conference on magnetism and magnetic materials; Baltimore, MD, USA (17 Nov 1986).

The electronic structure of $Nd_2Fe_{14}B$ has been calculated using the first-principles orthogonalized linear combination of atomic orbitals method. The f electrons in Nd are included in the calculation but are treated as localized states in the determination of the Fermi energy. Results are presented for the total density of states (DOS), orbital-decomposed and spin-decomposed partial DOS. The calculated spin-magnetic moments on each of the six Fe sites are in good agreement with the values deduced from neutron scattering experiment. The charge density map and the spin density map on the basal plane of the tetragonal cell show the evidence for covalent bonding between Fe and B atoms and reveal the distortion from the spherically symmetric distribution around the atomic sites.

25251 (CONF-870495—1) **Kinetic investigations of alkoxysilane sol-gel processing.** Hardman-Rhyne, K.A.; Coyle, T.D.; Lewis, E.P.; Spooner, S. (National Bureau of Standards, Washington, DC (USA). Ceramics Div.; Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007664.

From Conference on better ceramics through chemistry; Palo Alto, CA, USA (15 Apr 1987).

Effective control of sol-gel glass processing requires a detailed understanding of the kinetic and mechanistic aspects of the process. We have investigated structural evolution at the molecular level in the tetramethoxysilane (TMOS) hydrolysis reaction by various spectroscopic techniques. Development of structure at the macromolecular level and evolution of particle/network dimensionality have been studied by small-angle x-ray scattering (SAXS) in both hydrogenated and fully deuterated reactions for silica macromolecular structural development.

25252 (CONF-870505—3) **Failure prediction of Si_3N_4 ceramics by NDE [nondestructive evaluation].** Singh, J.P.; Roberts, R.A.; Vaitekunas, J.J.; Ellingson, W.A. (Argonne National Lab., IL (USA)). Oct 1986. Contract W-31-109-ENG-38. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006996.

From 32. international gas turbine conference and exhibition; Anaheim, CA, USA (31 May 1987).

Results are presented for the nondestructive evaluation (NDE) and fractographic observations of the critical flaws in hot-pressed Si_3N_4 with Fe inclusions. The NDE methods employed included low-energy contact radiography with digital image enhancement, through-transmission ultrasonic, and backscatter ultrasonic imaging. A comparison of NDE and fractography results indicate that the backscatter ultrasonic method may be more suitable than low-kV contact radiography for the detection of near-surface flaws.

25253 (CONF-8609268—1) **Characterization of metal oxide particles by gas adsorption.** Herman, R.G.; Zettlemoyer, A.C. (Lehigh Univ., Bethlehem, PA (USA). Center for Surface and Coatings Research). 18 Sep 1986. Contract FG22-83PC60786. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008134.

From 3. international symposium on particle size analysis and powder technology; Balatonfured, Hungary (18 Sep 1986).

Gas adsorption is a convenient and sensitive method for studying the surface area and texture of metal oxide particles. Although there are potential problems due to faults in the BET and pore modelling theories and experimental problems such as dead-space factors, gas adsorption is an indispensable tool for determining the partitioning of the surface into non-porous and porous contributions. Determination of the presence (or absence) of porosity is of special importance with materials such as catalysts, semiconductors, ceramics and adsorbents. The examples given in this paper illustrate that the relative importance of the different types and sizes of pores in influencing particular processes, methanol synthesis in this case, can be assessed to provide an understanding of the physical state of the gas-solid interface.

25254 (DOE/ER/45090—3) **Irradiation damage microstructures in nuclear ceramics with application in fusion energy technology and nuclear waste disposal: Progress report for the period 15 January 1986-1 March 1987.** Hobbs, L.W. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering). 1987. Contract FG02-84ER45090. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007107.

This grant supports research on fundamental radiation responses of ceramic materials of potential application in fusion energy or nuclear waste storage environments. Four areas of investigation have been emphasized in the last 13 months: radiolysis and Frenkel pair stabilization in BeO; metamictization (amorphization) of the initially crystalline perovskite ceramics $KTaO_3$ and $CaTiO_3$ by heavy ion implantation and subsequent recrystallization behavior; nanostructure of pyrochlore-phase ceramics of potential use as nuclear waste storage media; and investigation of medium-range structural order in network silicates by physical and computer modelling. Progress in each area is discussed.

25255 (DOE/ER/45115—3) **Microstructural effects in solid-particle erosion: Progress report for the period January 1, 1986 to January 1, 1987.** Conrad, H.; Scattergood, R.O. (North Carolina State Univ., Raleigh (USA). Dept. of Materials Science and Engineering). 1987. Contract FG05-84ER45115. 191p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87005344.

This report is the third and final progress report. The primary focus of the research is to study the fundamental role of microstructure and microstructural constraints in solid-particle erosion. The various material systems that have been studied are summarized and discussed in this report. The report is divided into self-contained sections, which are abstracted separately.

25256 (DOE/ER/45115—3, pp 8-25) **Flux effects in solid-particle erosion.** Anand, K.; Conrad, H.; Scattergood, R.O. 1987. NTIS, PC A09/MF A01. File Number DE87005344.

In Microstructural effects in solid-particle erosion: Progress report for the period January 1, 1986 to January 1, 1987.

Systematic measurements of the steady-state erosion rate as a function of erodent particle flux were made for a range of different erosion conditions. A significant decrease in erosion rate with increasing flux was observed. A first-order particle collision model was developed that provides a physical basis for describing the flux effect. The data confirm the exponential dependence of the erosion rate on flux predicted by the model. Further analysis of the data within the context of the collision model also provides new insight into the particle impact process. 11 figs., 2 tabs.

25257 (DOE/ER/45115—3, pp 82-122) **MgO-partially stabilized zirconia.** Srinivasan, S.; Scattergood, R.O. 1987. NTIS, PC A09/MF A01. File Number DE87005344.

In Microstructural effects in solid-particle erosion: Progress report for the period January 1, 1986 to January 1, 1987.

There seems to be marked improvement in the resistance to erosion by solid particle impact due to transformation toughening in PSZ. Samples that do not exhibit toughening have erosion resistances comparable to conventional brittle ceramics. The heat treatment given to PSZ toughening sample does not seem to have a great effect on erosion rates but still seems to be affected by toughness except for very low angles of impact, where the surface hardness seems to be important. A study of single impacts and steady state erosion rates of the samples at low and high impact angles yields interesting information about the effect of tangential component of velocity. Comparison of erosion rates at the same normal component of velocity for 20 and 90 degree impact conditions show an upward displacement of data points for the low angle impact condition. The result when quantified as the Percentage Upward Displacement seems to enable comparison of mechanical behavior of different materials spanning from brittle to ductile materials. This method of quantification can be a good scale to assess the ductility of a material. Prediction of material behavior in an actual application environment should become possible with further quantification for a wider range of materials. Brittle materials seem to fall into two regimes as regards their behavior. One of purely brittle material of extremely low toughness and the other with a limited plasticity. The erosion process in PSZs could not be modeled due to lack of models for the toughening effect. Also, erosion models are not in complete agreement regarding the effect of toughness on erosion rate.

25258 (DOE/ER/45115—3, pp 123-139) **Solid particle erosion of commercial and model aluminas.** Morrison, C.T.; Scattergood, R.O.; Routbort, J.L. 1987. NTIS, PC A09/MF A01. File Number DE87005344.

In Microstructural effects in solid-particle erosion: Progress report for the period January 1, 1986 to January 1, 1987.

This is an update on the continuing investigation of solid particle erosion on polycrystalline and multiphase materials by C.T. Morrison at NCSU in conjunction with Argonne National Laboratory. In addition to the continuing analysis of test results reported in the last progress report, room temperature erosion experiments were carried out on an additional commercial alumina and four model aluminas. These experiments were carried out at ANL on a slinger type erosion tester, details of which are reported elsewhere. A complete statistical analysis of Norton No. 38 Alundum abrasive is also in progress. These are the Al_2O_3 particles used in all ANL experiments conducted by Mr. Morrison. The erosion results to date indicate that microstructural constraints have a definite effect on the degradation processes present in aluminum oxide subjected to erosion by a stream of solid particles. There is a systematic increase in erosion rate with an increase in either void content or intergranular glassy phase in small grain aluminum oxide. The size of the alumina grains has an effect on which erosion mechanisms are predominant when eroded with 43 μm diameter Al_2O_3 particles. The ratio of particle size to grain size was shown to affect the value of the velocity exponent. 13 figs.

25259 (DOE/ER/45115—3, pp 140-189) **Erosion of WC-Co alloys.** Anand, K.; Conrad, H. 1987. NTIS, PC A09/MF A01. File Number DE87005344.

In Microstructural effects in solid-particle erosion: Progress report for the period January 1, 1986 to January 1, 1987.

Research during this period included: the erosion behavior of alloys with higher Co content (15 to 50 wt %) and with Ni (6 wt %) as a binder, measurements of the impact crater area and volume and damage features using SEM, x-ray diffraction studies on WC grains before and after erosion, and the degree of fragmentation of the impacting particles. The erosion behavior of the higher Co alloys was similar to that observed previously for lower Co contents in regard to the effects of scaling between the impact crater size and the WC grain size. Again, two scaling size regimes were found: the impact crater encompassed only a few WC grains and the impact crater encompasses many WC grains. In the former, the erosion behavior is of the brittle-type and the mechanism of material removal is mainly by the cracking and crushing of WC grains. In the latter, the erosion behavior is of the ductile-type with displacement along the binder phase of large masses of material containing plastically deformed WC grains intact. The erosion rate for the brittle-type mode increased with WC grain area to about 3 μm^2 and then remained relatively constant; that for the ductile-type increased linearly with square root of the mean free binder path. The erosion behavior for the Ni binder was similar to that for the Co. The erodent particles were found to fragment upon impact, the amount of fragmentation increasing with particle size and velocity. It is concluded that the degree of fragmentation did not influence the indicated effects of microstructure on erosion. However, fragmentation probably did influence the effect of particle flux rate on the erosion rate and possibly also the effect of particle size on the velocity exponent. 28 figs., 8 tabs.

25260 (LBL—22353) **Improved Beta" -alumina oxide electrolytes through transformation toughening: Final report.** Lange, F.F.; Miller, K.T. (Rockwell International Corp., Thousand Oaks, CA (USA). Science Center). Oct 1986. Contract AC03-76SF00098. 61p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007897.

A colloidal method which ensures phase homogeneity has been developed for processing β''-Al_2O_3/ZrO_2 composites. Pressure filtration kinetics and mechanics were examined for flocced and dispersed Al_2O_3 slurries over the applied pressure range of 0.04 to 80 MPa.

25261 (LBL—22753) **The role of particle substructure in the sintering of monosized titania.** Edelson, L.H. (California Univ., Berkeley (USA)). Dec 1986. Contract AC03-76SF00098. 109p. NTIS, PC A06. File Number DE87007600.

This study examined the sintering behavior of compacts comprised of monodispersed agglomerates and correlates changes in macroscopic dimensions with changes in particle microstructure and chemistry. Monosized titania particles (0.35μm) prepared by controlled hydrolysis of titanium tetraethoxide in ethanol were found to be porous agglomerates of about 60 A primary particles. The total volume shrinkage during sintering was 84%. Five contributions to the total shrinkage were identified: removal of chemisorbed water about 12% linear shrinkage, from ambient to 250°C), crystallization to anatase about 13% linear shrinkage between 250 and 425°C), intra-agglomerate densification (about 13%, 425 to 600°C), conversion of anatase to rutile (about 5% linear between 600 and 800°C), and intraaglomerate densification (7% linear shrinkage above 800°). Thus, about half the compact shrinkage is the result of agglomerate substructure changes. Studies of the agglomerate structural evolution indicate the interagglomerate densification crystallite growth rates, rather than crystallization and the polymorphic transformation, are the secondary factors, after compact packing, that influence microstructure development. This indicates control of intra-agglomerate structure is an important and necessary processing consideration even though particle size and particle packing are tightly controlled. This study indicates that particle substructure can generate unexpected shrinkage and that failure to adequately control intraparticle structure can deleteriously affect the resulting microstructure finished ceramic.

25262 (N—87-11892) **Thermal barrier coating life prediction model development. Annual report.** Demasi, J.T. (Pratt and Whitney Aircraft, East Hartford, CT (USA)). Nov 1986. 213p. (NASA-CR—179508; NAS—1.26:179508; AR—2). NTIS, PC A10/MF A01.

A methodology is established to predict thermal barrier coating life in a environment similar to that experienced by gas turbine airfoils. Experiments were conducted to determine failure modes of the thermal barrier coating. Analytical studies were employed to derive a life prediction model. A review of experimental and flight service components as well as laboratory post evaluations indicates that the predominant mode of TBC failure involves thermomechanical spallation of the ceramic coating layer. This ceramic spallation involves the formation of a dominant crack in the ceramic coating parallel to and closely adjacent to the topologically complex metal ceramic interface. This mechanical failure mode clearly is influenced by thermal exposure effects as shown in experiments conducted to study thermal pre-exposure and thermal cycle-rate effects. The preliminary life prediction model developed focuses on the two major damage modes identified in the critical experiments tasks. The first of these involves a mechanical driving force, resulting from cyclic strains and stresses caused by thermally induced and externally imposed mechanical loads. The second is an environmental driving force based on experimental results, and is believed to be related to bond coat oxidation. It is also believed that the growth of this oxide scale influences the intensity of the mechanical driving force.

25263 (N—87-15305) Adhesion, friction, and deformation of ion-beam-deposited boron nitride films. Miyoshi, K.; Buckley, D. H.; Alterovitz, S. A.; Pouch, J. J.; Liu, D. C. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1987. 16p. (NASA-TM—88902; E—3326; NAS—1.15:88902; CONF-870746—1). NTIS, PC A02/MF A01.

From International conference on tribology; London, UK (1 Jul 1987).

Institution of Mechanical Engineers.

The tribological properties and mechanical strength of boron nitride films were investigated. The BN films were predominantly amorphous and nonstoichiometric and contained small amounts of oxides and carbides. It was found that the yield pressure at full plasticity, the critical load to fracture, and the shear strength of interfacial adhesive bonds (considered as adhesion) depended on the type of metallic substrate on which the BN was deposited. The harder the substrate, the greater the critical load and the adhesion. The yield pressures of the BN film were 12 GPa for the 440C stainless steel substrate, 4.1 GPa for the 304 stainless steel substrate, and 3.3 GPa for the titanium substrate.

25264 (N—87-16113) Morphology of zirconia particles exposed to d-c arc plasma jet. Zaplatynsky, I. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Jan 1987. 17p. (NASA-TM—88927; E—3325; NAS—1.15:88927). NTIS, PC A02/MF A01.

Zirconia particles were sprayed into water with an arc plasma gun in order to determine the effect of various gun operating parameters on their morphology. The collected particles were examined by XRD and SEM techniques. A correlation was established between the content of spherical (molten) particles and the operating parameters by visual inspection and regression analysis. It was determined that the composition of the arc gas and the power input were the predominant parameters that affected the melting of zirconia particles.

25265 (PB—87-153953/XAB) Ceramics for heat-exchanger applications in high-temperature corrosive flue streams. Appendix A. Topical report, April 1984-May 1986. Morrow, J.D.; Larsen, D.C.; Bortz, S.A. (IIT Research Inst., Chicago, IL (USA)). Jun 1986. 86p. (IITRI-M—08260-1). NTIS, PC A05/MF A01.

The topical report reviews the use of heat exchangers in high-temperature corrosive flue streams and the accomplishments of the work GRI is funding in the area. Traditional and state-of-the-art heat exchangers are discussed with regard to their benefits and limitations on plant operations. High-temperature furnaces and flue environments are reviewed to show how heat-exchanger efficiencies can be improved and what corrosive conditions must be resisted by component materials. The new ceramic materials (silicon nitride, silicon carbide, composites) are discussed to indicate their application to heat-exchanger construction. Design considerations and life-cycle testing of components are reviewed, pointing out the different problems that must be overcome with ceramic versus metal components. The report concludes with a review of work on eight GRI contracts directed toward applying ceramics to heat-exchanger developments.

25266 (UCRL—15829) Investigation of platinum alloys for melting of inclusion free laser glass: Final report. Izumitani, T.; Toratani, H.; Meissner, H.E. (Hoya Optics, Inc., Fremont, CA (USA); Lawrence Livermore National Lab., CA (USA)). 28 Feb 1986. Contract W-7405-ENG-48. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008160.

The objective of this work is to evaluate the suitability of Pt alloys as crucible materials for melting LHG-8 phosphate laser glass. The tendency of forming metallic inclusions and ionic dissolution of alloy components in the glass is to be compared with that of pure Pt. Ionic Pt is introduced into the glass melt by direct dissolution of Pt at the crucible-melt interface and by vapor phase transport. It was felt that a Pt-alloy may behave sufficiently differently from Pt that a number of alloys should be studied. Pt inclusions may originate from Pt which reprecipitates from the glass melt on cooling or change in redox-conditions; from volatilized Pt which deposits in colder zones of the melting environment as crystallites which may drop back into the glass melt; and/or from Pt particles which are mechanically removed from the crucible and drop into the glass melt. Besides pure Pt, the following alloys have been tested: Pt/^{10}Ir, Pt/^{10}Rh, Pt/^{5}Au, Pt-ZGS, Pt/^{5}Au-ZGS, Pt/^{10}Rh-ZGS.

25267 (UCRL—15895) Research and development of improving the pumping efficiency of phosphate laser glass: Final report. Izumitani, T. (Hoya Optics, Inc., Fremont, CA (USA); Lawrence Livermore National Lab., CA (USA)). 15 Jul 1985. Contract W-7405-ENG-48. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008161.

It is well known that Pt inclusion in laser glass remarkably lowers the damage threshold by laser beam. Present commercial laser glasses are produced so as to minimize the Pt inclusion. However, the damage due to small Pt inclusion, which has never seriously caused the laser damage in a lower fluence level, is getting to be a problem as the output fluence of laser increases. In NOVA system, most of laser glasses were damaged at fluence of 3 to 4 J/cm^2. Since NOVA has been planned to operate at 10 J/cm^2, this damage threshold is absolutely unacceptable and it should be increased. In this report we will show the basic conception to make a Pt inclusion free glass and its experimental results.

25268 (UCRL—15896-Rev.) Low loss laser glass: Final report. Izumitani, T.; Toratani, H.; Meissner, H.E. (Hoya Optics, Inc., Fremont, CA (USA); Lawrence Livermore National Lab., CA (USA)). 15 Jan 1987. Contract W-7405-ENG-48. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008162.

The objective of this work was a process development on making a laser glass with loss coefficient of 10^{-4}cm^{-1} at 1.05μ. The key issues for making such a low loss glass will be to use pure raw materials, to reduce OH content and to prevent contamination from the melting environment. A sublimation method was tried to prepare pure P_2O_5 batch material. In an attempt to distinguish contributions to the overall loss, glasses were melted in furnaces which were controlled in moisture as well as contamination. Evaluation of glass samples at LLNL are expected to provide guidance on the importance of various process parameters. A new 0.5 liter furnace which almost completely prevents contamination by the furnace environment has been constructed to obtain useful information for making a low loss glass on a production scale.

25269 High-energy-neutron vibrational spectroscopy on β-V_2H. Hempelmann, R.; Richter, D.; Price, D.L. (Institut fuer Festkoerperforschung, Kernforschungsanlage Juelich, 5170 Juelich, West Germany). *Physical Review Letters;* **58**: No. 10, 1016-1019(9 Mar 1987).

By means of inelastic neutron scattering we investigated the localized H vibrations in β-V_2H (octahedral H sites). Using a unique single-domain single crystal, for the first time we determined the directions of the fundamental excitations of a hydrogen atom in a metal. Overtones of these vibrations were observed up to the fourteenth order. They establish a well-defined H potential up to more than 1 eV. The sequence of the excitations could be described in terms of an empirical potential.

25270 Lattice instability and high-T/sub c/ superconductivity in La/sub 2-//sub x/Ba/sub x/CuO$_4$. Jorgensen, J.D.; Schuettler, H.h.; Hinks, D.G.; Capone II, D.W.; Zhang, K.; Brodsky, M.B.; Scalapino, D.J. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review Letters;* **58**: No. 10, 1024-1027(9 Mar 1987). Contract W-31-109-ENG-38.

La/sub 1.85/Ba/sub 0.15/CuO$_4$ exhibits high-T/sub c/ superconductivity with an onset temperature near 33 K as measured by resistivity and magnetic susceptibility. The nonsuperconducting end-member compound, La$_2$CuO$_4$, which has an orthorhombic, Cmca structure, exhibits semiconducting behavior. The orthorhombic distortion is proposed to result from a Peierls 2k/sub F/ instability or a soft zone-boundary phonon mode. The role of Ba is to suppress the instability and stabilize a higher-symmetry tetragonal, I4/mmm structure which is metallic and superconducting.

25271 High temperature refractory of MgCr/sub 2/O/sub 4/ matrix and unstabilized ZrO/sub 2/ particles. Singh, J.P.; James, J.J.; Picciolo, J.J. (to Dept. of Energy, Washington, DC). US Patent 4,647,547. 3 Mar 1987. Filed date 10 Dec 1985. vp.

This patent describes a sintered refractory product consisting essentially of MgCr/sub 2/O/sub 4/ as a matrix and about 5-30 wt.% unstablized ZrO/sub 2/ formed from particles of ZrO/sub 2/ having an average size below about 5 microns and above about 0.6 microns.

25272 High-energy (MeV) ion-beam mixing of Ti with SiC and Si$_3$N$_4$. Bhattacharya, R.S.; Rai, A.K.; Pronko, P.P. (Universal Energy Systems, Inc., 4401 Dayton-Xenia Road, Dayton, Ohio 45432). *Journal of Materials Research;* **2**: No. 2, 211-215(Mar 1987).

Ion-beam mixing of Ti layers with sintered α-SiC and hot-pressed Si$_3$N$_4$ was measured for 1 MeV Au$^+$ at doses of 1 x 10^{16} cm^{-2} and 5 x 10^{16} cm^{-2}. Rutherford backscattering (RBS) and cross-section transmission electron microscopy (XTEM) were used to evaluate the mixing. Mixing was observed in Ti/SiC system; however, there was no mixing in Ti/Si$_3$N$_4$ system. Results are discussed in light of the enthalpy of mixing criterion for metal-insulator systems.

25273 (AD-A—175568/5/XAB) Low-temperature synthesis of ZrO$_2$-TiO$_2$ and SiO$_2$ glass from Zr(NO$_3$)$_4$, Ti(OC$_4$H9)$_4$ and Si(OC$_2$H$_5$)$_4$. Li-song, H.; Cong-shan, Z.; Juan-Juan, X. (Air Force Systems Command, Wright-Patterson AFB, OH (USA). Foreign Technology Div.). 26 Nov 1986. Translation of Guisuanyan Xuebao (China), Vol. 11, No. 4, 422-429(Dec 1983). (FTD-ID(RS)T—0852-86). 20p. NTIS, PC A02/MF A01.

Using Zr(NO$_3$)$_4$.5H$_2$0 as one of the starting materials, glasses in the system ZrO$_2$-TiO$_2$-SiO$_2$ were prepared by the sol-gel method. The influence of various factors on the gelling properties of the system, the variation of viscosity with time of the reaction system, the different environmental conditions on the unity of gel mass and the effect of heat-treatment conditions on the final results were studied in detail. In order to investigate the change of dry gels during heat treatment, DTA and IR absorption spectroscopy analyses were also made. On the basis of these studies, small transparent glass pieces were obtained; some problems are discussed, such as the method of adding water into the reaction system and the function of Zr(4+) ion in the glass, etc.

25274 Process for fabrication of large titanium diboride ceramic bodies. Moorhead, A.J.; Bomar, E.S.; Becher, P.F. (to Dept. of Energy). US Patent Application 6-853,118. 17 Apr 1986. 28p. Contract AC05-84OR21400. DE87007234 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007234.

A process is disclosed for manufacturing large, fully dense, high purity TiB$_2$ articles by pressing powders with a sintering aid at relatively low temperatures to reduce grain growth. The process requires stringent temperature and pressure applications in the hot-pressing step to ensure maximum p of sintering aid and to avoid damage to the fabricated article or the die.

25275 Method for producing refractory nitrides. Quinby, T.C. (to Dept. of Energy). US Patent Application 6-849,625. 9 Apr 1986. 8p. Contract AC05-84OR21400. DE87007226 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007226.

Disclosed is a process for making fine, uniform metal nitride powders that can be hot pressed or sintered. A metal salt is placed in a solvent with Melamine and warmed until a metal-Melamine compound forms. The solution is cooled and the metal-Melamine precipitate is calcined at a temperature below 700°C to form the metal nitrides and to avoid formation of the metal oxide.

3606 Other Materials

REFER ALSO TO CITATION(S) 24596, 24628, 24708, 24785, 24786, 24789, 25131, 25210, 25243, 25346, 25399, 25399, 25483, 25491, 25712, 25730, 25736, 25962, 25963, 26213, 26214

25276 (CONF-870385—7) Transient enhanced diffusion in ion-implanted silicon. Pennycook, S.J.; Culbertson, R.J. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 10p. NTIS, PC A02. File Number DE87007659.

From SPIE conference on growth of compound semiconductors; Bay Point, FL, USA (22 Mar 1987).

We discuss the transient-enhanced diffusion of Sb, As, P, In, Ga, and B in ion-implanted Si, where the near-surface region has been amorphized by the dopant or by a self-implantation process. With Sb, a large transient diffusion enhancement is observed proportional to dopant concentration. For Sb, As, P, and In, the enhancement follows the relative interstitialcy diffusion coefficient. We believe this behavior is caused by stable implantation-induced point defects present in the amorphous surface layer, which decay during thermal processing to release high concentrations of self-interstitials. This process occurs in competition with the solid phase epitaxial (SPE) growth process, and for high dopant concentrations can occur in the amorphous phase ahead of the crystallization front. We believe this may be the origin of the dopant redistribution which can occur during SPE growth, which sets the upper limit to the dopant concentration which can be incorporated in the lattice by SPE growth. These effects are reduced for Ga and are absent for B, although transient enhanced diffusion of these species can still occur from defects emitted from the damaged crystal underlying the original amorphous/crystalline interface.

25277 (CONF-870588—1-Draft) Impurity atom location using axial-electron-channeling. Pennycook, S.J. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007658.

From 20. annual scanning electron microscopy conference; Hamilton, Canada (3 May 1987).

A new formulation is presented for the use of crystallographic orientation effects in electron scattering to determine impurity lattice location. The development of electron channeling techniques is reviewed and compared to high energy ion channeling and to the Borrmann effect in x-ray diffraction. The advantages of axial over planar geometry are emphasized. Delocalization effects are more serious for quantitative analysis than have generally been believed. The new formulation applies to any crystal lattice and quantitatively includes delocalization effects via c-factors, which have been experimentally determined for diamond structure semiconductors. For sublattice site location this formulation removes the two major approximations of the original ALCHEMI formulation, namely that all the inner shell excitations are perfectly localized, and that the projection of the impurity sites along the channeling direction coincides with the projection of the matrix. As an example, we study the location of small perfectly coherent Sb precipitates within the Si lattice.

25278 (DOE/ER/02899—1) **TEM [transmission electron microscopy] and EBIC [electron beam induced current] studies of defects in solar silicon: Final report.** Ast, D.G. (Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering). Dec 1986. Contract AC02-76ER02899. 106p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007751.

The presence of any defects can both degrade (recombination centers) and improve (gettering of impurities) the electrical properties of solar cells. In order to optimize cell efficiency an understanding is needed of the nature of the grown in defects, their interactions with chemical impurities and intrinsic point defects, and subsequent changes in the defect structure during processing. This report discusses the techniques which were used to characterize defects in solar cell silicon. Since all of the techniques have been used to study defects in single crystal silicon, an extensive literature is available on the principles of their operation. The major section of the report is devoted to results obtained with electron microscopy (including EBIC). Towards the end of the contract we began to use Fourier transform infrared absorption spectroscopy (FTIR) in an effort to characterize the oxygen content of WEB material and to possibly find a correlation between the dislocation content and dislocation decoration status and fine features in the FTIR spectrum.

25279 (DOE/ER/45070—2) **Drift mobilities by time-of-flight methods and time-dependent phototransport in the nanosecond regime in amorphous semiconductors: Annual report for period May 1, 1985-April 30, 1986.** Paul, W.; Eggert, J.R. (Harvard Univ., Cambridge, MA (USA)). Mar 1987. Contract FG02-84ER45070. 98p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87008021.

The general purpose of this work has been to clarify the steady-state photoelectronic properties of amorphous hydrogenated silicon and related semiconductors, and to contribute to understanding the underlying electronic band structure. The first phase of this work concentrated on transient phototransport measured on samples of doped and undoped a-Si:H. In the second year of this contract, we have concentrated on the examination of the possibility of investigating the doping of a-Si:H by P through neutron transmutation doping, examination of the theory of photoluminescence, completion of a study on the effect of carrier loss to deep traps during dispersive transport, and an experimental study of optical absorption involving states near mid-gap, caused by carrier injection at contacts.

25280 (DOE/ER/45104—3) **[Synthesis of model polymers and related structures in support of vinyl monomer grafting studies]: Progress report, 7/1/86-6/30/87.** Hogen-Esch, T.E. (Florida Univ., Gainesville (USA). Dept. of Chemistry). 25 Mar 1987. Contract FG05-84ER45104. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007406.

The objectives of the present program include the synthesis, structural characterization and properties, of cellulose-based water-soluble graft copolymers capable of effectively enhancing the viscosity of their aqueous solutions. In support of this program we plan the synthesis of a number of water-soluble well defined block- or star block copolymers capable of effectively viscosifying their aqueous solutions through reversible crosslinking. In order to understand the effects on rheology of branching or cyclization in the above systems, we also plan the synthesis of water-soluble cyclic- and star polymers.

25281 (DOE/ER/45115—3, pp 26-45) **Lateral cracks in glass.** Srinivasan, S.; Scattergood, R.O. 1987. NTIS, PC A09/MF A01. File Number DE87005344.

In Microstructural effects in solid-particle erosion: Progress report for the period January 1, 1986 to January 1, 1987.

Comparisons of data on lateral cracks between normal and 20 degree impact conditions appear to be best when made at the same normal component of particle velocity rather than at the absolute value. A definite upward shift in chipping probability and crack extension for oblique single impacts that have been observed would cause an increase in the steady state erosion as compared to normal incidence at the same normal component of velocity. This has also been observed in steady-state erosion results. Strength degradation results on glass also predicts the same trend as regards oblique (low angle) impacts. The measured crack extension to particle velocity relation fits the simple model for quasi-static contact conditions. Direct observation of crack extension, as done in this work, appears to be the most direct method to test such models. Steady-state erosion results reported in the literature suggest that particle size may affect the contact conditions. 8 figs., 3 tabs.

25282 (DOE/ER/45115—3, pp 46-70) **Erosion of SiC-reinforced alumina.** Sykes, M.T.; Scattergood, R.O.; Routbort, J.L. 1987. NTIS, PC A09/MF A01. File Number DE87005344.

In Microstructural effects in solid-particle erosion: Progress report for the period January 1, 1986 to January 1, 1987.

The erosion behavior of SiC-reinforced alumina matrix composites containing up to 25 wt % SiC fibers was investigated for a range of erodent particle sizes, velocities and impact angles. Additions of SiC fibers can provide a substantial improvement in the erosion resistance of the base alumina. The basic trends in the data can be explained using existing erosion models, but with suitable modifications to account for the effect of crack-closing pressure due to fiber pull-out on lateral crack propagation.

25283 (DOE/ER/45115—3, pp 71-81) **Erosion of SiC whisker reinforced silicon nitride.** Morrison, C.T.; Scattergood, R.O.; Routbort, J.L. 1987. NTIS, PC A09/MF A01. File Number DE87005344. Contract W-31109-ENG-38.

In Microstructural effects in solid-particle erosion: Progress report for the period January 1, 1986 to January 1, 1987.

The steady-state solid particle erosion behavior of hot-pressed Si_3N_4 reinforced with 0, 10, and 20 wt % SiC whiskers has been investigated at room temperature using angular alumina particles (63 to 270 μm dia) as the erodent. The impact angle was varied from 30 to 90^0 and particle velocities were varied from 80 to 140 m/s. These materials were found to be very erosion resistant. However, there was little effect of the SiC whisker reinforcement on either the absolute erosion rate or on the velocity or particle-size exponents for the rates. The lack of a fiber reinforcement effect occurs even though the fiber additions provide an increase in the fracture toughness at high fiber contents. Results on differently processed Si_3N_4 base materials showed that microstructural variations due to processing history have a very significant influence on the erosion resistance of the base (matrix) material. The results substantiate the idea that microstructure plays an important, but not fully understood, role in the erosion processes for brittle materials.

25284 (DOE/ER/45170—3) **Theoretical studies on the structures of insulating and metallic glasses: Annual progress report for period July 1, 1986-June 30, 1987.** Ching, Wai-Yim. (Missouri Univ., Kansas City (USA). Dept. of Physics). Mar 1987. Contract FG02-84ER45170. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007867.

This is the third year of a three-year project to study the electronic and structural properties of glassy systems by means of large scale theoretical calculations. Major accomplishments covered in this report are: study of ground state properties of AlN and other wurtzite crystals within the local density functional theory; calculation of electronic structures of (Na_2O)/sub x/(SiO_2)/sub 1-x/ , $0 \leqq x \leqq 0.33$ glasses using previously constructed structural models with periodic boundaries; extensive study of electronic and magnetic properties of rare earth-iron-boron compounds; construction of periodic models of a-Ni, a-Fe, and a-Mg/sub x/Zn/sub 1-x/ metallic glasses; and development of computer programs for optical conductivity calculation in amorphous insulators and metallic glasses.

25285 (DOE/ER/45261—T1) **Structural disorder and transport in ternary oxides with the pyrochlore structure: Progress report for period July 1, 1986-February 1, 1987.** Tuller, H.L. (Massachusetts Inst. of Tech., Cambridge (USA). Crystal Physics and Optical Electronics Lab.). 1987. Contract FG02-86ER45261. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006919.

The ionic conductivity of $Gd_2Ti_2O_7$-$Gd_2Zr_2O_7$ solid solutions was studied as a function of Ti/Zr ratio. Lattice constant, order parameter and absorbance of these mixtures were also studied. (DLC)

25286 (INPE—009-PRE/1001) Density of states due to pairing of impurities in semiconductor systems. Deandradaesilva, E.A.; Dacunhalima, I.C.; Ferreiradasilva, A. (Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil)). Oct 1986. 18p. NTIS, PC A02/MF A01.

The pair formation of hydrogen - like impurities in 3-D and 2-D systems is studied. The density of states is obtained for the ground state of the H_2 - like molecule and H_2+ - like ion for concentrations realizable in doped semiconductors and MOS structures. The joint density of states for the transition H_2 yields H_2+ is also obtained. The calculated bandwidth shows that pair formation is relevant in those systems.

25287 (LBL—22871) Alteration of national glass in radioactive waste repository host rocks: A conceptional review. Apps, J.A. (Lawrence Berkeley Lab., CA (USA)). Jan 1987. Contract AC03-76SF00098. 42p. (CONF-870581—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006939.

From Symposium on glass and ceramics for nuclear repositories; Madrid, Spain (21 May 1987).

The storage of high-level radioactive wastes in host rocks containing natural glass has potential chemical advantages, especially if the initial waste temperatures are as high as 250°C. However, it is not certain how natural glasses will decompose when exposed to an aqueous phase in a repository environment. The hydration and devitrification of both rhyolitic and natural basaltic natural glasses are reviewed in the context of hypothetical thermodynamic phase relations, infrared spectroscopic data and laboratory studies of synthetic glasses exposed to steam. The findings are compared with field observations and laboratory studies of hydrating and devitrifying natural glasses. The peculiarities of the dependence of hydration and devitrification behavior on compositional variation is noted. There is substantial circumstantial evidence to support the belief that rhyolitic glasses differ from basaltic glasses in their thermodynamic stability and their lattice structure, and that this is manifested by a tendency of the former to hydrate rather than devitrify when exposed to water. Further research remains to be done to confirm the differences in glass structure, and to determine both physically and chemically dependent properties of natural glasses as a function of composition.

25288 (LBL—23016) The structure and electrical properties of metal contacts on GaAs. Liliental-Weber, Z. (Lawrence Berkeley Lab., CA (USA)). Jan 1987. Contract AC03-76SF00098. 39p. (CONF-870167—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008217.

From Conference on physics and chemistry of semiconductor interfaces; Salt Lake City, UT, USA (27 Jan 1987).

This paper reports a study of the structural and analytical properties of Au and Al contacts on GaAs and their change in the range of temperatures where the Schottky barrier height changed. The annealing of Au contacts above 290°C caused the Schottky barrier height to decrease, an effect opposite to that of Al, where the Schottky barrier height increased upon annealing. An increase in As in the GaAs under the as-deposited metal was consistently found in both cases, whereas annealing seems to change the As/Ga ratio in an opposite way for Au and Al. The orientation relationship of the Au contacts changed upon annealing, which was not observed with the annealed Al. The orientation relationship depended strongly on the surface preparation before the metal deposition and on the annealing environment. It was proposed that the presence of As at the interface can determine the orientation relationship between metals and GaAs.

25289 (LBL—23041) Spin-wave turbulence. Bryant, P.; Jeffries, C.; Nakamura, K. (Lawrence Livermore National Lab., CA (USA); Fukuoka Inst. of Tech. (Japan)). Feb 1987. Contract AC03-76SF00098. 16p. (CONF-870159—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE87008218.

From International conference on physics of chaos and systems far from equilibrium; Monterey, CA, USA (11 Jan 1987).

A high resolution study is made of spin-wave dynamics above the Suhl threshold in a sphere of yttrium from garnet driven by microwave ferromagnetic resonance. In different regions of parameter space observed behavior includes: excitation of a single spatial spin-wave mode at threshold; when two modes are excited, low frequency collective oscillations with a period doubling route to chaos; nonperiodic relaxation oscillations; when three modes are excited, quasiperiodic route to chaos; abrupt hysteretic onset of wide-band chaos. These results are accounted for in a unified way by numerical iteration of a model: coupled quantum oscillators representing the photons of the cavity and the magnons, including four-magnon scattering processes.

25290 (MHSMP—87-07) A new deaeration technique for fluid polymers. Montague, J.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Mar 1987. Contract AC04-76DP00487. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006878.

By incorporating a mechanical vibrator or a rotating disk into the presently used deaeration system, the time required to deaerate adhesive polymers can be drastically reduced. The mechanical vibrator is efficient but it requires electrical power. The rotating disk deaerator can use a compressed air motor in a high explosives area or an electric motor in other areas. The rotating disks can easily be fabricated as low cost disposable items.

25291 (N—87-12356) Zone leveling and solution growth of complex compound semiconductors in space. Final report, 1 May 1983-30 September 1986. Bachmann, K.J. (North Carolina State Univ., Raleigh (USA)). Oct 1986. 28p. (NASA-CR—179884; NAS—1.26:179884). NTIS, PC A03/MF A01.

A research program on complex semiconducting compounds and alloys was completed that addressed the growth of single crystals of CdSe(y)Te(1-y), Zn(x)Cd(1-x)Te, Mn(x)Cd(1-x)Te, InP(y)As(1-y) and CuInSe2 and the measurement of fundamental physico-chemical properties characterizing the above materials. The purpose of this ground based research program was to lay the foundations for further research concerning the growth of complex ternary compound semiconductors in a microgravity environment.

25292 (N—87-12680) Investigation of the effects of cobalt ions on epoxy properties. Singh, J.J.; Stoakley, D.M. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Dec 1986. 16p. (NASA-TP—2639; L—16196; NAS—1.60:2639). NTIS, PC A02/MF A01.

The effects of Co(acac)sub x complexes on MY-720 epoxy properties have been investigated. It appears that some types of ions form antibonding or nonbonding orbitals which increase the free volume and also reduce the cohesiveness of the host epoxy, while others hand, seem to result in increased cohesiveness of the epoxy. The experimental values of magnetic moments of both types of ions in MY-720 suggest that the orbital momentum contributions of the (3d) electrons are partially conserved. The coordination environment of the cobalt ions in the host epoxy does not appear to be uniquely defined. These results indicate that the effects of metal ions on resin properties cannot be easily predicted on the basis of ligand field theory argument alone. Complex interactions between metal ions and host epoxy molecular structure suggest the desirability of parallel experimental investigations of electronic, magnetic, and mechanical properties of metal ion-containing epoxy samples for comparison with theory.

25293 (N—87-16071) PMR polyimide compositions for improved performance at 371 deg C. Vannucci, R. D. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1987. 13p. (NASA-TM—88942; E—3390; NAS—1.15:88942; CONF-870408—1). NTIS, PC A02/MF A01.

From 32. international SAMPE symposium and exhibition on advanced materials technology; San Diego, CA, USA (6 Apr 1987).

Studies were conducted to identify matrix resins which have potential for use at 371 C (700 F). Utilizing PMR methodology, neat resin moldings were prepared with various monomer reactants and screened for thermo-oxidative stability at 371 C (700 F) under both ambient and a four-atmosphere air pressure. The results of the resin screening studies indicate that high molecular weight (HMW) formulated resins of first (PMR-15) and second (PMR-II) generation PMR materials exhibit lower levels of weight loss at 371 C (700 F) than PMR-15 and PMR-II resins. The resin systems which exhibited the best overall balance of processability, Tg and thermo-oxidative stability at 371 C were used to prepare unidirectional Celion 6000 and T-40R graphite fiber laminates. Laminates were evaluated for thermo-oxidative stability and 371 C mechanical properties. Results of the laminate evaluation studies indicate that two of the resin compositions have potential for use in 371 C applications. The most promising resin composition provided laminates which exhibited no drop in 371 C mechanical properties and only 11 percent weight loss after 200 hr exposure to 4 atmospheres of air at 371 C.

25294 **(SAND—86-1169C) A model for silicon dendrite growth during laser/plasma deposition from a silane discharge.** Anderson, H.M.; Hargis, P.J. Jr. (Sandia National Labs., Albuquerque, NM (USA); New Mexico Univ., Albuquerque (USA). Dept. of Chemical and Nuclear Engineering). 1986. Contract AC04-76DP00789. 9p. (CONF-861207—94). NTIS, PC A02. File Number DE87007579.

From Materials Research Society fall meeting; Boston, MA, USA (1 Dec 1986).

A model for dendrite growths in polycrystalline Si films formed during laser/plasma deposition with a silane discharge and a pulsed KrF laser has been developed. The model assumes a thin (less than 10 nm) amorphous silicon (a-Si) film is deposited on a substrate prior to phase transformation due to laser heating. The observed dendritic structure of the overall polycrystalline Si films is attributed to Si crystals shooting from an excessively supercooled Si liquid bath. Supercooled liquid forms since the melting point for a-Si can be reached at relatively low KrF laser fluences. Latent heat evolved at the solid-liquid interface induces an interface temperature higher than that of the melt and the requisite negative temperature gradient for absolute bath supercooling. Since the formation of an undercooled liquid by fast melting a-Si is also an important first step in explosive crystal regrowth studies, these results may have important implications for crystal growth and transient annealing. A conical approximation model is used in this study to characterize the stability of the dendrite tip in terms of local temperature gradients, i.e., the degree of undercooling at the tip of the parabolic dendrite. The degree of undercooling and hence the tip radius appears to be significantly affected by small changes in the laser fluence. Stability criteria lead to a relationship between regrowth velocity, V, and the tip radius, R, of the form VR^2 = constant. The size and stability of the dendrite tip is determined from a balance between the destabilizing force due to thermal diffusion and the stabilizing capillary force. Based on the observed tip radii formed at laser fluences from 0.13 to 0.25 J/cm^2, the model predicts regrowth velocities in a range between 2.0 and 20 m/s - values consistent with transient annealing studies of a-Si.

25295 **(SAND—86-1290C) A mechanistic study of the interaction of ultraviolet laser radiation with low density polymers.** Hargis, P.J. Jr. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 9p. (CONF-861207—96). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007846.

From Materials Research Society fall meeting; Boston, MA, USA (1 Dec 1986).

Ultraviolet laser radiation at 248 nm and 266 nm was used to ablate low density (0.04 to 0.14 g/cm^3) microcellular polystyrene and TPX foams at laser fluences between 0.1 and 1000 J/cm^2. The dependence of the etch rate on laser fluence and foam density is consistent with a linear absorption mechanism for the initial stages of the ablation process. Studies of the morphology and chemical composition of the ablated foams as a function of laser fluence and foam density show that the degree of melting increases at the higher foam densities. Blackbody and radical specie contributions to optical emission from the ablated foam were readily resolved for correlation with laser fluence, foam density, absorption spectra, and etch depth. Temperatures in excess of 3000°K are calculated from emission spectra observed during the ablation of polystyrene foams. From this data we conclude that chemical and thermal changes in the ablated foam are influenced by the absorption spectrum as well as the density of the foam.

25296 **(SAND—86-2169C) Foam rheology: the linear viscoelastic response of a spatially periodic model.** Kraynik, A.M. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 3p. (CONF-870533—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000960.

From 11. Canadian congress of applied mechanics; Edmonton, Canada (31 May 1987).

Foam is considered to be a dispersion of gas cells in a continuous network of thin liquid films. The interfacial properties that are essential to foam stability are equally important to foam rheology. This is illustrated by the linear viscoelastic response of a model foam. Spatially periodic models of foam rheology have provided insight into the cell-level mechanisms that are responsible for such properties as a finite shear modulus, yield stress, non-Newtonian viscosity, normal stresses, and shear strength. The analysis described here extends previous work by considering several new features: linear viscoelastic behavior, Gibbs' elasticity, and interfacial viscosity.

25297 **(SAND—86-2347C) Three-dimensional model for the linear elastic properties of a foam.** Warren, W.E.; Kraynik, A.M. (Sandia National Labs., Albuquerque, NM (USA)). Oct 1986. Contract AC04-76DP00789. 7p. (CONF-870533—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE87000984.

From 11. Canadian congress of applied mechanics; Edmonton, Canada (31 May 1987).

Tetrahedral strut junctions are predominant in foams whose synthesis route involves a liquid state. A general analysis of tetrahedral-joint mechanics is presented which is based upon a recent analysis of 2-D spatially periodic cellular materials. The deformation of an arbitarily oriented joint in uniaxial strain and pure shear is analyzed. Averaging the stresses over all possible joint orientations provides a consistent set of relations for determining the effective isotropic elastic constants for this 3-D foam model. (DLC)

25298 **(SAND—86-2581C) Temperature dependence of implantation damage in strained-layer superlattices.** Myers, D.R.; Arnold, G.W.; Dawson, L.R.; Biefeld, R.M.; Hills, C.R.; Doyle, B.L. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 8p. (CONF-870438—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007678.

From Spring meeting of the Materials Research Society; Anaheim, CA, USA (21 Apr 1987).

We have characterized damage production in both (InGa)As/GaAs and Ga(AsP)/GaP strained-layer superlattices for silicon implants at 80 K, 300 K or 673 K at fluences sufficient to induce compositional disordering of the superlattice layers. Implants at low temperatures (80 K for the (InGa)As/GaAs system, 300 K and below in the Ga(AsP)/GaP system) are characterized by well-drained amorphous layers at depths consistent with the predictions of ion range codes. Implants at higher temperatures are characterized by greatly reduced damage levels with substantial densities of extended defects located near the mean ion range. Point defect clusters are preferentially located in the ternary layers in the (InGa)As/GaAs SLS at the deepest part of the implanted zone. Despite the absence of amorphous layer formation, precipitous stress relief still occurs for the Si-implanted (InGa)As/GaAs SLS.

25299 **(SAND—87-0139C) Shock-enhanced dissolution of silicate minerals: An important planetary surface process.** Boslough, M.B.; Cygan, R.T. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 3p. (CONF-870396—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87006709.

From Lunar and planetary science conference; Houston, TX, USA (16 Mar 1987).

This study was undertaken to examine the effect of shock loading on rock-water interactions and on the dissolution of silicate phases. Shock-recovery experiments were carried out on oligoclase, hornblende, and labradorite. No additional crystalline phases or glass were produced, although mean grain size was decreased and specific surface area increased. Dissolution experiments were conducted; the extracted solutions are being analyzed. (DLC)

25300 (SAND—87-0402C) Fundamentals of sol-gel thin film formation. Brinker, C.J.; Hurd, A.J.; Ward, K.J. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 23p. (CONF-870254—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007387.

From 3. international conference on ultrastructure processing of ceramics, glasses, and composites; San Diego, CA, USA (23 Feb 1987).

It is shown that the structure of sol-gel-derived thin films depends on the precursor structure and deposition conditions. Weakly branched precursors (reduced D) applied under reaction-limited conditions result in the densest films, whereas branching or aggregation (increased D) combined with transport-limited deposition conditions result in the most porous films. A complete spectrum of microstructures is achievable by independent control of both precursor size and structure and the condensation rate or sticking probability. Application of shear during deposition is shown to restructure tenous, fractal structures and align weakly branched precursors.

25301 (SAND—87-0832C) Refractory films from spin-cast polyacrylonitrile. Renschler, C.L.; Sylwester, A.P. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 10p. (CONF-870438—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007851.

From Spring meeting of the Materials Research Society; Anaheim, CA, USA (21 Apr 1987).

Polyacrylonitrile (PAN) films have been spin-cast and pyrolyzed to produce thin (500 to 1500 A) carbon films. These films have higher electrical conductivities than carbon films produced by other methods at similar temperatures. The conductivity can be varied by at least four orders of magnitude by changing the pyrolysis temperature. UV, IR, and Raman spectroscopies were used to investigate the chemical structure of the films during different stages of processing.

25302 (UCID—20907) White paper on nanocomposites as harmonic generation media. Eimerl, D.; Velsko, S. (Lawrence Livermore National Lab., CA (USA)). 30 Oct 1986. Contract W-7405-ENG-48. 45p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008337.

Nanocomposites (composites containing 5 to 50 nm particles) may be a flexible and inexpensive way to make large area harmonic generators, and may also provide noncritically phase-matched harmonic generators at wavelengths where none are currently available. There does not appear to be any extreme optical requirements on either the matrix or the microcrystallites. Scattering may well be significant, and reducing it to acceptable levels will require the use of either very small microparticles or strongly nonlinear microparticles, depending on the degree of long range order in the nanostructure of the nanocomposite.

25303 (UCRL—15341-82-84) Growth of KH_2PO_4 crystals at constant temperature and supersaturation: Final report, 20 August 1982-30 May 1984. Loiacono, G.M.; Zola, J.; Kostecky, G. (Lawrence Livermore National Lab., CA (USA); Philips Labs., Briarcliff Manor, NY (USA)). Aug 1985. Contract W-7405-ENG-48. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008167.

The maximum growth rate of KH_2PO_4 (KDP) along the z axis appears to be limited by the initiation of x-y growth which results in flaws. Using the three-zone crystallizer, the maximum z growth rate is 5 mm. day^{-1}. Attempts at limiting the x-y growth by impurity additions were found to be troublesome; this approach is not recommended. Higher growth rates of KDP are attainable by using increased mass transport obtained by forced solution flow coupled with precise supersaturation control. One approach to limiting x-y growth may involve the use of restraining barriers. Representative samples were supplied to Lawrence Livermore National Laboratory for test and evaluation.

25304 (UCRL—96256) Thermal fracture in selected nonlinear optical materials. Eimerl, D.; Marion, J.; Graham, E.K. (Lawrence Livermore National Lab., CA (USA); Pennsylvania State Univ., University Park (USA)). 2 Mar 1987. Contract W-7405-ENG-48. 11p. (CONF-870132—102). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008213.

From LASE-13: pulse power for lasers conference; Los Angeles, CA, USA (11 Jan 1987).

The fracture temperature is a figure of merit describing the resistance of a crystal to thermal fracture. It has been determined as function of orientation of the normal to the plate surface for three common nonlinear and electrooptic materials (KDP, $LiIO_3$, $LiNbO_3$), and for the new material, barium borate. For the first three materials, the fracture temperature is small, between 3 and 20°C. However, barium borate appears to be about an order of magnitude more resistant to thermal fracture than the other three.

25305 Two-photon absorption in ZnS calculated by an empirical pseudopotential method. White W.T. III; Yee, J.H.; Orvis, W.J. (Electronics Engineering Department, Lawrence Livermore National Laboratory, Livermore, California 94550). *Applied Physics Letters;* **50**: No. 17, 1128-1129(27 Apr 1987). Contract W-7405-ENG-48.

Using an empirical pseudopotential method, we have computed the spectrum of two-photon absorption (2PA) in cubic ZnS. The 2PA coefficients obtained this way agree better with experimental data than 2PA coefficients obtained from simpler band-structure calculations.

25306 Direct measurement of evaporation during rapid thermal processing of capped GaAs. Haynes, T.E.; Chu, W.K.; Picraux, S.T. (Department of Physics and Astronomy, University of North Carolina, Chapel Hill, North Carolina 27514). *Applied Physics Letters;* **50**: No. 16, 1071-1073(20 Apr 1987).

We have directly measured the amounts of arsenic evaporated through very thin encapsulating films during rapid thermal processing (RTP). The evaporated molecules are condensed onto a copper film on a sapphire substrate and subsequently counted using 5 MeV Rutherford backscattering analysis. For 20-nm-thick Si, SiO_2, and Si_3N_4 caps, we have determined the temperature ranges for which a 10-s RTP cycle produces less than $1 \times 10^{15}/cm^2$ of evaporated As. Preliminary measurements at higher temperatures of the thickness and time dependence of evaporation through SiO_2 caps of 20 to 60 nm thicknesses are also presented and discussed in terms of the mechanism of As loss.

25307 Ab initio determination of the structure of a grain boundary by simulated quenching. Payne, M.C.; Bristowe, P.D.; Joannopoulos, J.D. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physical Review Letters;* **58**: No. 13, 1348-1351(30 Mar 1987).

Results of the first completely ab initio investigation of the microscopic structure of a grain boundary in a semiconductor are presented. By use of the molecular-dynamics—simulated annealing method for performing total-energy calculations within the local-density—functional and pseudopotential approximation, the $\Sigma = 5$ (001) twist boundary in germanium is studied. A number of rotation-and-translation states are investigated leading to a prediction for the structure of this geometry. Evidence for the possible presence of novel defects and glasslike tunneling mode states at grain boundaries is presented.

25308 Apparatus and method for the horizontal, crucible-free growth of silicon sheet crystals. Ciszek, T.F. (to Dept. of Energy, Washington, DC). US Patent 4,650,541. 17 Mar 1987. Filed date 12 Sep 1984. vp.

This patent describes an apparatus for crucible-free growth of a sheet crystal of silicon, the apparatus comprising; means for providing a substantially enclosed space having an inert atmosphere; heating means for sequentially forming molten silicon from a source of substantially pure silicon within the space; means for vertically feeding a silicon source toward the heating means to form a molten layer of silicon at a top of the source; means for drawing a continuous silicon sheet crystal from the molten silicon layer within the space; wherein a meniscus of molten silicon is created by the drawing means. The apparatus includes means to control the shape of the meniscus, and the controlling means includes a repulsive RF generator for repulsive support of the meniscus as a molten silicon sheet crystal is drawn from the molten silicon. A crucible-free, nondendritic growth method is described for continuously forming a silicon crystal sheet from a rod of substantially pure silicon, the method comprising: employing an RF heating means having first and second portions to provide a molten layer at an end of the silicon rod in an inert atmosphere by actively heating a first region at the end of the silicon rod while preventing an active heating of a second region of the end of the silicon rod.

25309 Keefer and Schaefer respond. Keefer, K.D.; Schaefer, D.W. (Sandia National Laboratories, Albuquerque, New Mexico 87185-5800). *Physical Review Letters;* **58**: No. 11, 1155-1155(16 Mar 1987). Contract AC04-76DP00789.

A reply to the comment on growth of fractally rough colloids is presented. (AIP)

25310 Energetics of single dangling and floating bonds in amorphous Si. Fedders, P.A.; Carlsson, A.E. (Department of Physics, Washington University, St. Louis, Missouri 63130). *Physical Review Letters;* **58**: No. 11, 1156-1156(16 Mar 1987).

A Comment on the Letter by S. T. Pantelides, Phys. Rev. Lett. 53, 2979 (1986).

25311 Composition/bandgap selective dry photochemical etching of semiconductor materials. Ashby, C.I.H.; Dishman, J.L. (to Dept. of Energy, Washington, DC). US Patent 4,648,938. 10 Mar 1987. Filed date 11 Oct 1985. vp.

A method is described of selectively photochemically dry etching a first semiconductor material of a given composition and direct bandgap E/sub g1/ in the presence of a second semiconductor material of a different composition and direct bandgap E/sub g2/, wherein E/sub g2/>E/sub g1/. The second semiconductor material is not substantially etched during the method, comprising subjecting both materials to the same photon flux and to the same gaseous etchant under conditions where the etchant would be ineffective for chemical etching of either material where the photons are not present, the photons being of an energy greater than E/sub g1/ but less than E/sub g2/, whereby the first semiconductor material is photochemically etched and the second material is substantially not etched.

25312 Dopant type and/or concentration selective dry photochemical etching of semiconductor materials. Ashby, C.I.H.; Dishman, J.L. (to Dept. of Energy, Washington, DC). US Patent 4,648,936. 10 Mar 1987. Filed date 11 Oct 1985. vp.

A method is described of selectively photochemically dry etching a first semiconductor material of a given composition in the presence of a second semiconductor material which is of a composition different from the first material. The second material is not substantially etched during the method which comprises: subjecting both materials to the same photon flux of an energy greater than their respective direct bandgaps and to the same gaseous chemical etchant under conditions where the etchant would be ineffective for chemical etching of either material where the photons not present, the conditions also being such that the resultant electronic structure of the first semiconductor material under the photon flux is sufficient for the first material to undergo substantial photochemical etching under the conditions. The conditions also are such that the resultant electronic structure of the second semiconductor material under the photon flux is not sufficient for the second material to undergo substantial photochemical etching under the conditions.

25313 Solid-phase epitaxy of ion-implanted LiNbO$_3$ for optical waveguide fabrication. Buchal, C.; Ashley, P.R.; Appleton, B.R. (Oak Ridge National Laboratory, Solid State Division, Oak Ridge, Tennessee 37831). *Journal of Materials Research;* **2**: No. 2, 222-230(Mar 1987). Contract AC05-84OR21400.

A new technique for successfully fabricating high-quality optical waveguides in LiNbO$_3$ is reported. A high concentration of Ti is implanted with the substrate at liquid nitrogen temperature and an amorphous, Ti-rich, nonequilibrium phase is produced in the implanted, near-surface region. Subsequent thermal annealing in water-saturated oxygen atmosphere at up to 1000 °C initiates solid-phase epitaxial regrowth onto the crystalline substrate. A high-quality single crystalline layer results that is rich in Ti and has excellent waveguiding properties.

25314 Silicon oxidation and Si—SiO$_2$ interface of thin oxides. Ravindra, N.M.; Narayan, J.; Fathy, D.; Srivastava, J.K.; Irene, E.A. (Materials Science and Engineering Department, North Carolina State University, Raleigh, North Carolina 27695-7907). *Journal of Materials Research;* **2**: No. 2, 216-221(Mar 1987).

High-resolution transmission electron microscopy (HRTEM) and ellipsometry techniques have been employed to measure thicknesses of silicon oxide, grown at 800 °C in dry oxygen, in the thickness range of 2—20 nm. While the oxide growth data measured from TEM obey a nearly linear behavior, those obtained from ellipsometry are seen to vary nonlinearly. The interface structure as function of the increasing oxide thickness was studied using HRTEM. At these oxidation temperatures, the earlier reported variations of roughness at the interface on the oxide thickness for oxides grown at 900 °C are not seen. Attempts aimed at correlating the high-resolution transmission electron micrographs with some physical parameters like the refractive index and the dielectric breakdown lead to considerations of the importance of the effect of protrusions of silicon atoms of 1 mm size into SiO$_2$ layers on the interface properties. These findings lead to explanations of some key features concerning the refractive index and density of thin SiO$_2$.

25315 Electrothermal radiometric detection of the semiconductor-to-metal-phase transition in single-crystal (TaSe$_4$)$_2$I. Pekker, S.; Eyring, E.M. (Department of Chemistry, University of Utah, Salt Lake City, Utah 84112). *Applied Spectroscopy;* **41**: No. 2, 260-263(Feb 1987).

Electrothermal radiometry, a new radiometric technique for investigating phase transitions in semiconductors and metals, is described. Single crystals of (TaSe$_4$)$_2$I are heated by electric current pulses, and the thermal radiation of the samples is detected. The dependence of the electrothermal radiometry signal on the frequency and amplitude of the current pulses and on the temperature is discussed. The signal intensity is inversely proportional to the frequency. The static component of the temperature at the surface is obtained from the dependence on the current intensity. The temperature dependence is mostly determined by the change of the resistivity of the sample.

25316 Single-crystal structure of lead uranate(VI). Cremers, T.L.; Eller, P.G.; Larson, E.M.; Rosenzweig, A. (Los Alamos National Lab., NM, USA; University of South Florida, Tampa, USA. Dept. of Geology). *Acta Crystallographica, Section C: Crystal Structure Communications;* **42**: No. 12, 1684-1685(15 Dec 1986).

PbUO/sub 4/, M/sub r/=509.2, orthorhombic, Pbcm, a=5.536 (1), b=7.968 (2), c=8.212 (3) A, Z=4, V=362.24 A/sup 3/, D/sub x/=9.34 g cm/sup -3/, λ(MoKα)=0.71069 A, μ(MoKα)=889.1 cm/sup -1/, F(000)=824, T=298 K, R=0.048 for 530 unique observed reflections having I≧2σ(I). As in the case of BaUO/sub 4/, PbUO/sub 4/ forms a layered structure of (UO/sub 2/O/sub 4/)/sub ∞//sup 2-/ sheets, with the divalent cations in approximate seven coordination sandwiched between the layers. The uranyl groups are in typical octahedral coordiantion.

25317 (N—87-15284) Barium iron ruthenium oxide system. Kemmler-sack, S.; Ehmann, A. Translated from *Journal of Solid State Chemistry ;* **44**: No. 3, 366-373(Oct 1986). 15p. (NASA-TM—88451; NAS—1.15:88451). NTIS, PC A02/MF A01.

In the system BaFe(1-x)Ru(x)O(3-y), three phases, separated by immiscibility gaps, are present: an Fe-rich phase (x = 0 to 0.75) with hexagonal BaTiO$_3$ structure (6H; sequence (hcc)2), a Ru-rich phase (x = 0.9) of hexagonal 4H-type (sequence (hc)2), and the pure Ru compounds BaRuO3 with rhombohedral 9R structure (sequence (hhc)3)). By vibrational spectroscopic investigations in the 6H phase a transition from n-type semiconduction (Fe-rich compounds with complete O lattice) can be detected. The 4H and 9R stacking polytypes are good, metal-like conductors. The lattice parameters are given.

25318 Large single crystal quaternary alloys of IB-IIIA-Se_2 and methods of synthesizing the same. Ciszek, T.F. (to Dept. of Energy). US Patent Application 6-885,977. 15 Jul 1986. 24p. Contract AC02-83CH10093. DE87007197 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007197.

New alloys of Cu/sub x/Ag/sub (1-x)/$InSe_2$ (where x ranges between 0 and 1 and preferably has a value of about 0.75) and CuIn/sub y/Ga/sub (1-y)/Se_2 (where y ranges between 0 and 1 and preferably has a value of about 0.90) in the form of single crystals with enhanced structure perfection, which crystals are substantially free of fissures, are disclosed. Processes are disclosed for preparing the new alloys of Cu/sub x/Ag/sub (1-x)/$InSe_2$. The process includes placing stoichiometric quantities of a Cu, Ag, In, and Se reaction mixture or stoichiometric quantities of a Cu, In, Ga, and Se reaction mixture in a refractory crucible in such a manner that the reaction mixture is surrounded by B_2O_3, placing the thus loaded crucible in a chamber under a high pressure atmosphere of inert gas to confine the volatile Se to the crucible, and heating the reaction mixture to its melting point. The melt can then be cooled slowly to form, by direct solidification, a single crystal with enhanced structure perfection, which crystal is substantially free of fissures.

25319 Ternary rare earth-lanthanide sulfides. Takeshita, Takuo; Gschneidner, K.A. Jr.; Beaudry, B.J. (to Dept. of Energy). US Patent Application 6-836,881. 6 Mar 1986. 11p. Contract W-7405-ENG-82. DE87007302 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007302.

Disclosed is a new ternary rare earth sulfur compound having the formula La/sub 3-x/M/sub x/S_4, where M is europium, samarium, or ytterbium, with x = 0.15 to 0.8. The compound has good high-temperature thermoelectric properties and exhibits long-term structural stability up to 1000°C.

25320 Laser brazing. Witherell, C.E.; Ramos, T.J. (Lawrence Livermore National Lab., CA). pp 213 of Sixty-seventh American Welding Society annual meeting. Abstracts. Miami, FL; American Welding Society (1986). (CONF-8604123—).

From 67. annual American Welding Society meeting; Atlanta, GA, USA (13 Apr 1986).

Conventional brazing and fusion welding methods are satisfactory for most joining requirements. But traditional approaches are not always suitable for joining thin sections, precision assemblies, or for joining parts near heat-sensitive materials like glass, plastics and electronic components. The development of industrial lasers during the past decade has provided a precision heat source ideally suited to solving many of these unusual, although increasingly frequent, demands. Studies at Livermore over the past few years have shown how brazed joints can be successfully made using lasers and commercial grades of brazing alloys for joining a wide range of thin metals, alloys, and dissimilar combinations. This paper describes these methods and results and discusses advantages and limitations, along with comments on future prospects, for brazing with lasers.

25321 Improved high temperature refractory. Singh, J.P.; James, J.; Picciolo, J.J. (to Dept. of Energy). US Patent Application 6-807,097. 10 Dec 1985. 22p. Contract W-31-109-ENG-38. DE87007285 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007285.

A high chromia refractory composite has been developed with improved thermal shock resistance and containing about 5 to 30 wt % of unstabilized ZrO_2 having a temperature-dependent phase change resulting in large expansion mismatch between the ZrO_2 and the chromia matrix which causes microcracks to form during cooling in the high chromia matrix. The particle size preferably is primarily between about 0.6 to 5 microns and particularly below about 3 microns with an average size in the order of 1.2 to 1.8 microns.

25322 Method for making thin polypropylene film. Behymer, R.D.; Scholten, J.A. (to Dept. of Energy). US Patent Application 6-800,590. 21 Nov 1985. 20p. Contract W-7405-ENG-48. DE87007278 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007278.

An economical method is provided for making uniform thickness polypropylene film as thin as 100 Angstroms. A solution of polypropylene dissolved in xylene is formed by mixing granular polypropylene and xylene together in a flask at an elevated temperature. A substrate, such as a glass plate or microscope slide is immersed in the solution. When the glass plate is withdrawn from the solution at a uniform rate, a thin polypropylene film forms on a flat surface area of the glass plate as the result of xylene evaporation. The actual thickness of the polypropylene film is functional of the polypropylene in xylene solution concentration, and the particular withdrawal rate of the glass plate from the solution. After formation, the thin polypropylene film is floated from the glass plate onto the surface of water, from which it is picked up with a wire hoop.

25323 Intensities and asymmetries of electronic Raman scattering in $ErPO_4$ and $TmPO_4$. Becker, P.C.; Edelstein, N.; Williams, G.M.; Bucher, J.J.; Russo, R.E.; Koningstein, J.A.; Boatner, L.A.; Abraham, M.M. (Lawrence Berkeley Lab., CA). *Physical Review* [*Section*] *B: Solid State;* **31**: No. 12, 8102-8110(15 Jun 1985). Contract AC03-76SF00098;W-7405-ENG-26.

An investigation of the low-temperature electronic Raman scattering spectra of $ErPO_4$ and $TmPO_4$ has been carried out. The experimental intensities have been compared with the standard second-order theory of two-photon processes for both intermultiplet and intramultiplet transitions between individual crystal-field levels. Adequate agreement is found in the case of $ErPO_4$, but serious discrepancies exist for $TmPO_4$. It is shown that electronic Raman scattering is a sensitive technique for testing the Judd-Ofelt-type theories of two-photon processes in rare-earth crystals. Strong asymmetry, a characteristic feature of electronic Raman scattering, has been observed in several of the transitions.

25324 Nuclear spin ordering observed by neutron diffraction. Nicklow, R.M.; Moon, R.M.; Kawarazaki, S.; Kunitomi, N.; Suzuki, H.; Ohtsuka, T.; Morii, Y. (Oak Ridge National Lab., TN). *Journal of Applied Physics;* **57**: No. 1, 3784-3788(15 Apr 1985). Contract AC05-84OR21400.

A review is given of recent neutron scattering experiments which have been carried out at milli-Kelvin temperatures to study the hyperfine-enhanced nuclear-spin ordering in the singlet electronic ground state compounds $PrSn_3$, $PrCu_2$, and $HoVO_4$. Bragg peaks were observed in $PrSn_3$ which are due solely to the nuclear spin polarization of ^{141}Pr caused by the hyperfine field from the antiferromagnetically ordered electronic moment. The temperature dependencies of the nuclear polarization and the additional electronic polarization induced by the nuclear polarization have been measured in detail. A magnetic phase transition in $PrCU_2$ which is believed to correspond to a simultaneous ordering of both the nuclear and electronic spin systems has been observed at 58 mK. The positions of the magnetic diffraction peaks in reciprocal space are represented by G +/- tau, where G is a vector of the reciprocal lattice and tau = 0.24a* +/- 0.68c*, indicating that the magnetic periodicity is incommensurate with the chemical lattice. In $HoVO_4$ magnetic diffraction peaks due to the antiferromagnetic ordering of the nuclear spin system were observed below 4.5 mK. The observed magnetic structure and the dependence of the neutron diffraction intensities on magnetic field are consistent with the predictions of Bleaney on the basis of dipolar energy considerations. 8 references, 8 figures.

25325 Neutron scattering investigation of magnetic excitations at high energy transfers. Loong, C.K. (Argonne National Lab., IL). *Journal of Applied Physics;* **57**: No. 1, 3772-3777(15 Apr 1985).

The authors have measured, using chopper spectrometers and time-of-flight techniques, the magnetic response functions of a series of d and f transition metals and compounds over a wide range of energy and momentum transfer. In PrO_2, UO_2, $BaPrO_3$, and CeB_6 the authors observed crystal-field transitions between the magnetic ground state and the excited levels in the energy range from 40 to 260 meV. In materials exhibiting spin-fluctuation or mixed-valent character such as Ce/sub 0.74/Th/sub 0.26/, on the other hand, no sharp crystal-field lines but a broadened quasielastic magnetic peak was observed. The line width of the quasielastic component is thought to be connected to the spin-fluctuation energy of the 4f electrons. The significance of the neutron scattering results in relation to the ground state level structure of the magnetic ions and the spin dynamics of the f electrons is discussed. 26 references, 7 figures.

25326 Dynamical threshold behavior of a sliding charge density wave. Sokoloff, J.B. (Northeastern Univ., Boston, MA). *Journal of Physics C: Solid State Physics;* **18**: 1641-1646(1985). Contract FG02-84ER45079.

It is argued that the existence of a dynamical threshold field (i.e. the value of the electric field such that when the applied field is reduced to this value the charge density wave (CDW) stops sliding) requires that the sliding) requires that the sliding of the CDW at low center-of-mass velocity occurs as a local sudden jumping motion reminiscent of stick-slip friction. 25 references.

25327 Analytical electron microscopy of surface-modified ceramics. Sklad, P.S. (Oak Ridge National Lab., TN). pp 276-279 of Proceedings of the 43rd annual meeting of the Electron Microscopy Society of America. Bailey, G.W. (ed.). San Francisco, CA; San Francisco Press, Inc. (1985).

Structural ceramics are attractive materials for advanced energy systems but their mechanical properties, oxidation resistance and wear resistance depend critically on surface properties. Ion implantation techniques offer a way to overcome some of the surface limitations of ceramics and electron microscopy is an ideal way to characterize ion implanted surfaces. To illustrate analytical electron microscopic techniques in ceramics studies of ion implantation in silicon carbide, titanium boride and alpha-alumina are described.

25328 Secondary ion mass spectrometric analysis of oxygen self-diffusion in single-crystal MgO. Yoo, H.; Wuensch, B.J.; Petuskey, W.T. (Massachusetts Institute of Technology, Cambridge). *Advances in Ceramics;* **10**: 394-405(1985). Contract AC02-76ER01198.

Single-crystal layers of $\mathrm{Mg^{18}O}$ were grown epitaxially on substrates of normal MgO through chemical transport with HCl. Exchange between ^{18}O in the crystals and the ^{16}O present in air was produced by annealings in the temperature range of 1000-1650°C, and diffusion coefficients were detemined from concentration gradients measured with the aid of secondary ion mass spectrometry. The temperature dependence of the oxygen self-diffusion coefficients so obtained may be represented by an activation energy of 3.24 +/- 0.13 eV and D_0 of (1.8/sub -1.1//sup +2.9/) x 10^{-6} cm^2/s. The magnitude of the diffusivities is lower than that first obtained by exchange measurements but agrees well with recent values obtained from gradients established through proton activation analysis. The present activation energy is in the middle of the range reported in previous studies. This value is too large to represent an enthalpy for anion vacancy migration and is far too small to represent the combination of defect migration and formation enthalpies to be expected if, as presently believed, the defect structure of MgO were dominated by cation impurities. 22 references, 5 figures, 1 table.

25329 Laser-heated miniature pedestal growth apparatus for single-crystal optical fibers. Fejer, M.M.; Nightingale, J.L.; Magel, G.A.; Byer, R.L. (Stanford Univ., CA). *Review of Scientific Instruments;* **55**: No. 11, 1791-1796(Nov 1984).

The authors have designed and built a single-crystal fiber growth apparatus. The apparatus employs novel optical, mechanical, and electronic control systems that enable the growth of high optical quality single-crystal fibers. The authors have grown oriented single-crystal fibers of four refractory oxide materials, Al_2O_3, $Cr:Al_2O_3$, Nd:YAG, and $LiNbO_3$. These materials exhibit similar growth characteristics and yield fibers of comparable quality. Fibers as small as 20 μm in diameter and as long as 20 cm have been grown. Measured optical losses at 1.06 μm for a 10-cm-long, 170-μm-diam $Cr:Al_2O_3$ fiber were 0.074 dB/cm. 28 references, 9 figures, 1 table.

25330 Microstructure analysis of Ni-SiC mixed layers. Fathy, D.; Narayan, J.; Holland, O.W.; Appleton, B.R.; Davis, R.F. (Oak Ridge National Lab., TN). *Materials Letters;* **2**: No. 4B, 324-327(May 1984). Contract W-7405-ENG-26.

The techniques of high-resolution and microanalytical electron microscopy and RBS have been applied to the study of the composition and structural variation of mixed regions obtained by pulsed-laser or ion-beam irradiation of Ni on single crystals of β-SiC. The results indicate that mixing takes place with a distribution depending on the ion dose or pulsed-laser energy used. 3 references, 5 figures.

25331 Structure and phonons in potassium mercurographitides. Kamitakahara, W.A.; Eklund, P.C.; Delong, L.E.; Yang, M.H. (Univ. of Kentucky, Lexington). pp 861-862 of LT-17. Eckern, U.; Schmid, A.; Weber, W.; Wuehl, H. (eds.). Amsterdam, Netherlands; Elsevier Science Publishers B.V. (1984). Contract W-7405-ENG-82;AS05-81ER10936.

Neutron scattering methods were applied to study the intercalant ordering and the lattice dynamics of the superconducting graphite intercalation compounds $KHgC_4$ and $KHgC_8$. Two coexisting phases with different intercalant ordering schemes were found for $KHgC_4$. In $KHgC_8$, only one phase was observed, with only two-dimensional ordering of the intercalant. 7 references, 2 figures.

25332 Thermally induced optical scintillations from single crystals of unirradiated BeO:Li and BeO:Na. Cooke, D.W.; Lianos, D.; Gavathas, E.; Alexander, C. Jr.; Shul'gin, B.V.; Jahan, M.S. (Los Alamos National Lab., NM). *Ferroelectrics;* **59**: 187-195(1984).

Optical scintillations from single crystals of BeO:Li and BeO:Na have been observed in the temperature interval 15-575 K. These scintillations result from subjecting the crystals to a temperature ramp and do not require previous irradiation. It is suggested that pyroelectricity forms the basis for adequately explaining this phenomenon. The electric field near the surface is related to the surface temperature gradient by E = (λ/sub T/d/kappa epsilon$_0$) ΔT/ΔX, where λ/sub T/ is the pyroelectric coefficient, d is the charge-separation distance, and kappa is the dielectric constant. For small changes in ΔT/ΔX (perhaps as small as 0.26 K/mm), an electric field of sufficient magnitude to break down air is produced. The optical spectrum of these scintillations corresponds to the second positive system of molecular nitrogen. It is shown that there exists a correlation between the temperature region of maximum scintillation activity and the temperature region where an anomalous heat capacity is observed in these samples. 33 references, 3 figures, 1 table.

25333 Segregation, supersaturated alloys and semiconductor surfaces. White, C.W.; Zehner, D.M.; Campisano, S.U.; Cullis, A.G. (Oak Ridge National Lab., TN). pp 81-132 of Surface modification and alloying. Poate, J.M.; Foti, G.; Jacobson, D.C. (eds.). New York, NY; Plenum Publishing Corporation (1983).

It has been shown that the properties of the surface region of Si crystals can be altered by laser annealing in a UHV environment. The production of atomically-clean surfaces in processing times << 1 sec and the restoration of geometric order to the surface region of a damaged crystal indicate that this technique provides an alternative approach to conventional surface preparation procedures. When combined with ion implantation, laser annealing can be used to tailor both the geometric lattice (interatomic spacings) and electron structure in the surface region. These observations indicate that laser annealing of surfaces in UHV has potential as a tool for both surface science and practical application. Although it has been tested extensively only on Si crystals, the results obtained suggest that it will be applicable to a wide range of materials. Additional investigations concerned with the surface properties of materials irradiated with the laser as well as the changes that occur by varying the annealing conditions (regrowth velocity, depth of melt) need to be performed in order to characterize and understand this processing technique more completely.

40 CHEMISTRY

4001 Analytical And Separations Chemistry

REFER ALSO TO CITATION(S) 24450, 24496, 24516, 24517, 24595, 24625, 24635, 24670, 24700, 25278, 25810, 25823, 26315

25334 (BDX—613-3686) **Plating and plating solution analysis by inductively coupled argon plasma spectrometer: Final report.** Reimer, H. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). Feb 1987. Contract AC04-76DP00613. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006579.

Plating solutions containing rhodium, gold, copper, tin, and zinc were analyzed for major constituents and trace impurities. Results of synthetic and real baths analyzed by an inductively coupled argon plasma spectrometer (ICAP) were compared to results obtained by using classical chemical methods to determine accuracy. Tin-lead plated deposits and solder were analyzed for tin, lead, and 11 other elements considered impurities. Rhodium and gold solutions were assayed for inventory purposes. Gold plating was analyzed by determining 26 elements to meet a pure gold specification requirement of 99.9%. Results indicated that the ICAP methods that were developed had sufficient accuracy to be used for control of plating operations and precious metal inventory. 4 refs., 4 tabs.

25335 (BDX—613-3702) **Laser microprobe analysis and laser Raman spectroscopy analysis techniques for identification of organic surface contaminants: Final report.** Cook, C.J. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). Mar 1987. Contract AC04-76DP00613. 76p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007828.

The application of laser microprobe analysis and laser Raman spectroscopy to identify and characterize trace organic surface contaminants is described. Prepared polymer samples that represent typical sources of surface contaminants were analyzed utilizing these two techniques.

25336 (BNL—39301) **Role of nuclear analytical probe techniques in biological trace element research.** Jones, K.W.; Pounds, J.G. (Brookhaven National Lab., Upton, NY (USA)). 1985. Contract AC02-76CH00016. 24p. (CONF-8505112—10). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006913.

From 2. international symposium on the biology and toxicology of metals using nuclear analytical methods; Upton, NY, USA (20 May 1985).

Many biomedical experiments require the qualitative and quantitative localization of trace elements with high sensitivity and good spatial resolution. The feasibility of measuring the chemical form of the elements, the time course of trace elements metabolism, and of conducting experiments in living biological systems are also important requirements for biological trace element research. Nuclear analytical techniques that employ ion or photon beams have grown in importance in the past decade and have led to several new experimental approaches. Some of the important features of these methods are reviewed here along with their role in trace element research, and examples of their use are given to illustrate potential for new research directions. It is emphasized that the effective application of these methods necessitates a closely integrated multidisciplinary scientific team. 21 refs., 4 figs., 1 tab.

25337 (BNL—39424) **Study of condensational growth of water droplets by optical Mie scattering spectroscopy.** Fung, K.H.; Tang, I.N. (Brookhaven National Lab., Upton, NY (USA)). Feb 1987. Contract AC02-76CH00016. 7p. (CONF-870583—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006748.

From International symposium on optical particle sizing: theory and practice; Rouen, France (12 May 1987).

Optical Mie scattering technique is applied in the study of the growth of a single saline solution droplet. A quadrupole particle chamber is used to suspend a charged sodium chloride solution droplet in a water vapor environment. The droplet-vapor equilibrium is momentarily shifted by the heating effect of an infrared laser and the subsequent condensational growth of this droplet is monitored by means of right angle Mie scattering. Simultaneous mass and heat transfer processes are considered, and the mass accommodation coefficient for water is deduced. 7 refs., 3 figs.

25338 (CONF-870410—11) **Storage and preservation of environmental samples.** Maskarinec, M.P.; Moody, R.L. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004271.

From 193. national meeting of the American Chemical Society; Denver, CO, USA (5 Apr 1987).

The chemical analysis of environmental samples is complicated by the lack of a definitive data base establishing the allowable preanalytical holding times for such samples. This study is designed to establish the preanalytical holding times for volatile organic compounds in water and soil, and explosives in water and soil, under various storage conditions. Procedures are also being developed to reproducibly prepare the large number of samples necessary to create such a data base. These sample preparation procedures and the data base also will make it possible to produce materials for reference and quality assurance purposes. 3 refs.

25339 (CONF-870410—16) **Novel applications of continuous annular chromatography: Separation of sugars.** Howard, A.J.; Carta, G.; Byers, C.H. (Oak Ridge National Lab., TN (USA); Virginia Univ., Charlottesville (USA). Dept. of Chemical Engineering). 1987. Contract AC05-84OR21400. 35p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007367.

From 193. national meeting of the American Chemical Society; Denver, CO, USA (5 Apr 1987).

Continuous chromatographic separations of fructose-glucose-sucrose mixtures have been investigated experimentally in a laboratory-scale continuous annular chromatograph using Ca-exchanged Dowex 50W-X8 resin as adsorbent. Comparative chromatographic separation studies have also been conducted for the system using a conventional fixed-bed column packed with the same resin. Complete resolution of fructose-glucose mixtures could be obtained both in a 60 cm-long continuous annular chromatograph and in a conventional column of the same length with sugars feed concentration up to 200 g/L. In the four-component mixture blue dextran (higher molecular weight saccharide), sucrose, glucose and fructose complete rsolution of all species except sucrose-glucose under the relatively mild separating conditions tested. The experimental results have been analyzed in terms of approximate linear chromatographic theories for fixed and rotating beds. Bed properties and equilibrium and mass transfer parameters used in the model were obtained through independent experiments. With these parameters a good fit to the experimental results was obtained. Differences in feed mixtures and dispersion characteristics contribute to the minor offset between fixed bed and continuous chromatograph results. 21 refs., 12 figs., 3 tabs.

25340 (CONF-8606133—9) **Temperature dependent electron spin echo studies of polarons in donor- and acceptor-doped poly(p-phenylene): Structural studies.** Kispert, L.D.; Joseph, J.; Tang, J.; Bowman, M.K.; Van Brakel, G.H.; Norris, J.R. (Alabama Univ., University (USA). Dept. of Chemistry; Argonne National Lab., IL (USA)). 6 Jun 1986. Contract W-31109-ENG-38. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004973.

From International conference on science and technology of synthetic metals; Kyoto, Japan (1 Jun 1986).

Electron spin echo (ESE) measurements of donor-doped (Li, Na, K and Cs) and acceptor-doped (AsF_5) poly(p-phenylene), PPP, and fully deuterated PPP samples predict a temperature independent EPR linewidth equal to less than 0.65 gauss that decreases with increasing conductivity. In contrast, EPR linewidths either decrease or increase with decreasing temperature, are dependent on dopant and always exhibit a linewidth either equal to or larger than that predicted from ESE measurements. Deuteration studies indicate that rapid spin exchange is present. Analysis of these results suggest that an exchange exists between isolated radicals in equilibrium with polarons and bipolarons with the equilibrium in favor of bipolarons at 4 K.

25341 (DOE/ER/13040—30) Development and optimization of methodologies for analysis of complex hydrocarbon mixtures: Final technical report for the period 1 January 1983-31 December 1986. Laub, R.J. (San Diego State Univ., CA (USA). Dept. of Chemistry). 1987. Contract AC03-83ER13040. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006394.

The investigations of Part I were comprised of three major aspects of systems optimization in gas chromatography. First, the selection of the first three members of a set of standard stationary phases which exhibit high efficiency with concomitant high selectivity was carried out. The results included the synthesis and evaluation of a unique class of mesomorphic polysiloxane stationary phases (MEPSIL's). Next, studies of blended stationary phases in open tubular columns were undertaken. This was then followed by a detailed theoretical evaluation of the effects of blended mobile phases. Results included the formulation and evaluation of a unique equation of state for gases that is valid in many cases from 200 to 900 K. In Part II, several aspects of liquid-chromatographic retentions were examined. The results from each were used in efforts at understanding fundamental contributions to the partitioning process extant in LC. Thus, studies of LC separations with silica and reverse-phase sorbents were carried out. Several phases were then employed singly and in admixture with isochratic as well as gradient-elution mobile phases. The use of selective mobile-phase additives was also evaluated, as were temperature effects. Finally, a unified theory of retentions with multicomponent phases, applicable to all forms of chromatography (including ion-exchange), was developed. The theory made use of an extended form of the Langmuir sorption-isotherm relations.

25342 (DOE/ER/13534—1) [Carbon isotope fractionation in plants: Progress report]. (Wisconsin Univ., Madison (USA)). [1987]. Contract FG02-86ER13534. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006924.

The purpose of this work is to use carbon isotope fractionation as a means of studying photosynthetic efficiency in plants. During the past year we have developed a new short-term method for measuring the isotope fractionation over a period of about an hour. This method is being used to study a variety of environmental and developmental effects in both C_3 and C_4 plants, and these results are being compared with results of the traditional combustion method. We have made extensive studies of aspartic acid, malic acid, and citric acid as possible indicators of the functioning of phosphoenolpyruvate carboxylase in C_3 plants. We find that most of the aspartic acid in proteins in C_3 plants is synthesized by action of phosphoenolpyruvate carboxylase on atmospheric CO_2 and phosphoenolpyruvate produced by glycolysis. The metabolically active pool of malate, aspartate, and citrate, on the other hand, appear not to be principally synthesized by this route. Studies of C_4 plants are in progress. During deacidification, CAM plants lose CO_2 to the atmosphere, and this material is highly enriched in carbon-13. Field-grown and growth-chamber grown CAM plants show similar isotope fractionations. Ploidy effects on isotope fractionation in alfalfa are extremely small.

25343 (DOE/EV/04320—T2) An analytical chemical system for the determination of heavy metals and organic compounds: Technical report for the period December 1, 1983 to November 30, 1984. Barnes, R.M.; Siggia, S.; Uden, P.C. (Massachusetts Univ., Amherst (USA). Dept. of Chemistry). 2 Mar 1987. Contract AC02-77EV04320. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007737.

This project involved the synthesis, characterization, and application of sequestering resins for the measurement of inorganic species and organic compounds at trace and ultratrace levels found in energy-related materials. Emphasis was on development of new sequestering resins and the application of available resins. In addition, organic class separations, and metallo-organic complex and heteroatom speciation were accomplished by applying gas and liquid chromatographic techniques and specific element detection by plasma emission spectroscopy. A poly(dithiocarbamate) resin, the uptake capability of which has been investigated for 65 elements, was further evaluated for oxidation state selectivity and its reaction mechanisms, and applications developed for analysis of biological fluids and tissues, geological materials, seawater and brines, effluents, and sediments. An inductively coupled plasma (ICP) discharge spectroscopic source was employed for the analysis. Microvolume samples and resins without digestion were analyzed directly by electrothermal vaporization-ICP. Instrumentation and computer developments were undertaken on the ICP spectroscopic facility to automate diagnostics and analysis. The extended characterization of poly(acrylamidoxime) resin was conducted for inorganic species to complement the poly(dithiocarbamate) resin. New resins for inorganics were synthesized and evaluated. The development of other resins followed in the post-contract period based upon developments made during the contract.

25344 (DOE/PC/90515—T1) Entrainer effects in high pressure separation processes: Quarterly technical progress report for period December 15, 1986 to March 14, 1987. Donohue, M.D. (Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Chemical Engineering). 1987. Contract FG22-86PC90515. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008053.

The objective is to study the entrainer effect so that entrainer-solvent mixtures can be designed. The solubility of various hydrocarbons will be measured in solvents with and without entrainer-cosolvents to determine the relationship between solubility enhancement and functional groups. In addition, in situ spectroscopic measurement will be made to characterize the type of intermolecular interactions and to qualify the extent of chemical association. Progress during this quarter was made in both theoretical and experimental parts of the program. In the experimental part the design of the high pressure spectroscope cell was completed. A detailed report of the design is attached. In the theoretical part a correlation was developed for polar compounds which will determine the size of polar groups. In the last progress report it was stated that there is no independent theory for the determination of the size of a polar group. During this quarter such a theory was developed. In the theory, spectroscopically measured properties are correlated with equation of state parameters for isotropic interactions. The theory was developed by comparing quantum mechanical equations for dispersion and dipole-induced dipole interactions with the empirical Lennard-Jones equation. By doing so the empirical Lennard-Jones parameters (and hence the equation-of-state parameters) are given fundamental and explicit meaning in terms of quantities that can be measured spectroscopically. Ultimately the theory allows the determination of the size of a polar group. The derivation of the theory is outlined in Appendix A. A summary of the derivation and results are presented in this report. 1 ref., 2 figs.

25345 (DP—1723) Cerium oxalate precipitation. Chang, T.P. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Feb 1987. Contract AC09-76SR00001. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007832.

Cerium, a nonradioactive, common stand-in for plutonium in development work, has been used to simulate several plutonium precipitation processes at the Savannah River Laboratory. There are similarities between the plutonium trifluoride and the cerium oxalate precipitations in particle size and extent of plating, but not particle morphology. The equilibrium solubility, precipitation kinetics, particle size, extent of plating, and dissolution characteristics of cerium oxalate have been investigated. Interpretations of particle size and plating based on precipitation kinetics (i.e., nucleation and crystal growth) are presented. 16 refs., 7 figs., 6 tabs.

25346 (LBL—22936) Measurement of dopant concentration and lattice position in LEC GaAs by combined particle-induced x-ray emission and Rutherford backscattering techniques. Madok, J.H. (California Univ., Berkeley (USA). Dept. of Materials Science and Mineral Engineering). Dec 1986. Contract AC03-76SF00098. 183p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87008216.

The use of Particle-Induced X-Ray Emission (PIXE) to characterize electronic materials has advantages over the Rutherford Backscattering (RBS) technique. The major advantage is the ability to characterize impurities which are of either similar mass or of less mass than the target atoms, as well as those which are heavier than the target. When combined with RBS channeling measurements, PIXE can be used to extend the range of dopants whose lattice position can be studied. Furthermore, PIXE can be used to determine the specific sublattice site of impurities in III-V compounds. A scattering chamber which provides the capability to perform both PIXE and RBS measurements simultaneously was constructed. A series of experiments were carried out in which the experimental and data analysis procedures were standardized. Dopant concentration measurements of LEC GaAs show that concentrations can be measured with a 5 uncertainty and that fluctuations in concentration of 8 to 10 in 1 mm along a bulk crystal can be determined. The minimum detectable limit of the PIXE technique when employing 1.0 and 1.5 MeV protons for a wide range of impurities in bulk GaAs was investigated. PIXE analysis was performed in conjunction with RBS measurements to investigate the lattice position of In, Zn, and Si in as-grown crystals by the channeling technique.

25347 (N—87-15528, pp vp) **OH radical measurements by optical absorption spectroscopy.** Platt, U.; Ehhalt, D. H. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

The long path absorption spectroscopy (LPA) measurement of OH utilizes the strong UV absorption spectrum of the molecule with well resolved rotational lines around 308 nm. The light source consists of an Ar ion laser pumped CW dye laser, the output of which is frequency doubled to emit a spectrally smooth light profile of 0.1 nm FWHM at 308 nm. This is considerably broader than the sharp (0.0018 nm wide) absorption features of OH and also wider than the total spectral region (0.06 nm) scanned around the OH lines. For field measurements a Cassegrain-type telescope expands the small diameter of the original laser beam by a factor of 50 to about a 0.25-m diameter in order to reduce the divergence of the beam as well as its mean photon flux density, thus reducing the maximum self-generated OH concentration to 40,000 cu. cm. The light is passed into the open atmosphere and reflected at about 5 km distance resulting in a 10-km light path length. A telescope focuses the returning light onto the entrance slit of a monochromator the single exit slit of which is replaced by a mechanical scanning device operating at a scan repetition rate of 6.6 KHz. For a typical measurement (1h duration) some 20,000,000 scans are averaged, rendering the contribution of atmospheric turbulence to the spectral noise negligible.

25348 (N—87-15528, pp vp) **OH measurement by laser light absorption.** Perner, D. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

Since the first attempt to measure atmospheric hydroxyl radicals by optical absorption in 1975 (Perner et al., 1976) this method has been continuously developed further and its major obstacles and limitations are known today. The laser beam needs to be expanded in order to reduce the beam divergence. At the same time the energy density of the laser beam which produces OH via ozone photolysis is reduced to such an extent that the self-produced OH concentration ranges well below the atmospheric value. Atmospheric absorptions should be observed over a wide spectral range so that not only the OH radicals are properly identified by several rotational lines but their absorption can be corrected for interfering absorptions from other air constituents as SO_2, CH_2O, CS_2, etc., which can be identified in a wide spectral range with more confidence. Air turbulence demands fast spectral scanning or probing on and off the absorption line. Energy requirements should be kept small in field operations. In the experiment frequency doubled dye laser pulses at 308 nm are produced. The picosecond light pulses are expected to show a smooth profile (light intensity against wavelength) which will be broadened to the required spectral width according to the uncertainty principle. The pump laser will be an optoacoustically modulated Nd:YAG laser.

25349 (N—87-15528, pp vp) **Tropospheric HO determination by FAGE.** Hard, T. M.; Obrien, R. J.; Chan, C. Y.; Mehrabzadeh, A. A. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

In the detection of tropospheric HO by laser excited fluorescence, and alternative air-sampling method, named FAGE (Fluorescence Assay with Gas Expansion) was introduced. Here the air is expanded through a nozzle prior to excitation, in order to improve the ratio of the HO signal to the scattered, fluorescent, and photolytic backgrounds. The improvement comes from the differing pressure dependence of the intensities of these four terms, as well as the distinguishability of their temporal waveforms at low pressures when excited by a pulsed laser. HO has been excited by a YAG/dye laser. Other lasers and pumping paths may perform as well or better in this method. With FAGE, chemical modulation of the HO signal was achieved by hydrocarbon addition to the nozzle flow, converting photolytic HO from an interference to a background. Chemical calibration of the instrumental response to external HO was also achieved, by hydrocarbon decay, at HO concentrations within the ambient range.

25350 (N—87-15528, pp vp) **Two-photon laser-induced fluorescence detection of OH.** Davis, D. D.; Bradshaw, J. D.; Rodgers, M. O. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

The TP-LIF OH sensor is based on the principle that a molecule having multiple energy states, all of which are bonding, can be pumped into the highest state with the resulting fluorescence being blue-shifted relative to all pumping wavelengths. In this way, one can successfully discriminate against virtually all noise sources in the system using long wavelength blocking filters in conjunction with solar-blind photomultiplier tubes. Thus, these systems tend to be signal limited rather than signal-to-noise limited as is true of the SP-LIF technique as well as other conventional analytical methods. The trick to achieving the above sampling scheme, with high efficiency, is in the use of high photon fluxes of short time duration. Obviously, the latter type of light source is fulfilled nicely by available pulsed lasers. From an operational point of view, however, this laser source needs to be tunable. The latter characteristic permits extremely high selectivity for the detection of a diatomic or simple polyatomic molecule by taking advantage of the high-resolution spectroscopic features of these type species.

25351 (N—87-15528, pp vp) **Remote detection of OH.** Mcdermid, I.S.; Laudenslager, J. B. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

This is a remote measurement technique utilizing a XeCl excimer laser tuned to the $Q_{21}1$ rotational transition of the 0-0, A-X band at 307.847 nm. A wavemeter is under development to monitor, on a pulse-to-pulse basis, both the laser lineshape and absolute wavelength. Fluorescence is detected with a multiple Fabry-Perot type filter with a spectral resolution on the order of 0.001 nm. This is tuned to the overlapping Q_2 2, $Q_{12}2$, Q_2 3, and $Q_{12}3$ rotational transitions at 308.986 nm. The fringe pattern from this filter is imaged using a discrete, multi-anode detector which has a photon gain of 10 to the 8th power. This permits the simultaneous monitoring of OH fluorescence, N_2 and/or O_2 rotational Raman scattering and broadband background levels. The use of three etalons in series provides sufficient rejection, approx. greater than 10 to the 10th power, against the laser radiation only 1.2 nm away.

25352 (N—87-15528, pp vp) **Indirect determination of OH.** Singh, H. B. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

Efforts are under way to develop indirect OH measurement techniques by utilizing tailor made reactive OH tracers to be employed in estimating OH abundance within air masses over a 100 to 1,000 km transport distance. By simultaneously releasing controlled quantities of reactive and inert tracers, both dispersion and OH abundance can be determined. When fully developed, the method will be used at all expected levels of atmospheric OH concentrations. A number of candidate reactive OH tracers were selected after a careful screening process. Laboratory work is now under way to affirm the applicability of the selected chemicals to real world conditions.

25353 (N—87-15528, pp vp) **Measurement of atmospheric HO by a chemical method.** Iyer, R.S.; Rowland, F.S. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

The parameters for a chemical technique can be outlined from the following set of desirable goals: (1) sufficient conversion of tracer species A to product B that B can be measured quantitatively in the presence of A and a great excess of air; (2) specificity of reaction such that A is converted to B only by reaction with HO; and (3) sufficient sensitivity for detection that the ambient concentration of HO is not seriously perturbed by the presence of A and B. This proposed study involves finding a chemical reaction specific enough for OH, and a measurement of the product formed. What one wants is a rate constant of about 10 to the -10th power cu cm/s, so that 0.1 percent of the OH will be converted in 100 s. Laboratory studies are needed to find a reaction which will fill this bill, yielding a product in quantity sufficient for precise measurement. This is an extremely fast constant and the search may be difficult. Again there is a question of perturbing the local environment, while still providing a sensitive measurement. Also the temperature and pressure dependence of the reaction rate is a complicated function for many of these species (that is, one must use a RRKM or Troe-based picture), and must be taken into account.

25354 (N—87-15528, pp vp) **determination of the global average OH concentration using a deuteroethane tracer.** Stevens, C. M.; Cicerone, R. (National Center for Atmospheric Research, Boulder, Co). Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

It is proposed to measure the decreasing global concentration of an OH reactive isotopic tracer, $G_2 D_6$, after its introduction into the troposphere in a manner to facilitate uniform global mixing. Analyses at the level of 2 x 10 to the -19th power fraction, corresponding to one kg uniformly distributed globally, should be possible by a combination of cryogenic absorption techniques to separate ethane from air and high sensitivity isotopic analysis of ethane by mass spectrometry. Aliquots of $C_2 D_6$ totaling one kg would be introduced to numerous southern and northern latitudes over a 10 day period in order to achieve a uniform global concentration within 3 to 6 months by the normal atmospheric circulation. Then samples of air of 1000 l (STP) would be collected periodically at a tropical and temperate zone location in each hemisphere and spiked with a known amount of another isotopic species of ethane, C-13_2 H_6, at the level of 10 to the -11th power mole fraction. After separation of the ethanes from air, the absolute concentration of $C_2 D_6$ would be analyzed using the Argonne 100-inch radius mass spectrometer.

25355 (N—87-15528, pp vp) **Peroxy radical detection by chemical amplification (PERCA).** Stedman, D. H. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

Important reactions of atmospheric free radicals are the chain oxidation of NO and CO. Thus: H_2O + NO yields OH + NO_2; OH + CO yields H + CO_2; H + O_2 + M yields HO_2 + M. In most models, the need to know the free radical concentration could also be described as the need to know the rate of the above oxidation chain in the atmosphere. It is the total rate of this chain (also carried by RO_2 and RO) which was measured using the PERCA. The PERCA is thus essentially a RO/sub X/ meter. The PERCA works by adding excess CO (10%) and NO (5ppm) to a stream of air and measuring the NO_2 produced after 3s of reaction time. Since other processes produce NO_2, the chain reaction is modulated by switching the CO for N_2. The chain length is limited by the reaction OH + NO yields HONO and is modeled to be somewhat over 1000. Measured chain lengths agree with the modeled numbers.

25356 (N—87-15528, pp vp) **Fluorometric method for the determination of gas-phase hydrogen peroxide.** Kok, G. L.; Lazrus, A. L. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

The fluorometric gas-phase hydrogen peroxide procedure is based on the technique used by Lazrus, et. al., for the determination of H_2O_2 in the liquid phase. The analytical method utilizes the reaction of H_2O_2 with horse radish peroxidase and p-hydroxphenylacetic acid (POPHA) to form the fluorescent dimer of POPHA. The analytical reaction responds stoichiometrically to both H_2O_2 and some organic hydroperoxides. To discriminate H_2O_2 from organic hydroperoxides, catalase is used to preferentially destroy H_2O_2. Using a dual-channel flow system the H_2O_2 concentration is determined by difference.

25357 (N—87-15528, pp 99) **Tropospheric HO_2 determination by FAGE.** Obrien, R. J.; Hard, T. M.; Chan, C. Y.; Mehrabzadeh, A. A. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

The detection efficiency is greatest at low pressures, where the subsequent removal of the HO product by the NO reagent (via HO + NO + M yields HONO + M) is relatively slow. Moreover, nozzle expansion of the air from ambient to low pressures produces a turbulent zone that assists in mixing the reagent with the sample. If the HO product is observed by laser-excited fluorescence, then the other advantages of low-pressure detection by FAGE (Fluorescence Assay with Gas Expansion) also apply. The FAGE instrumental response was calibrated to external HO_2 by observing NO decay in the photolysis of HO-CH_2O mixtures and by choosing conditions in which HO_2 + NO is the only significant NO destruction path. HO_2 was determined in urban air.

25358 (N—87-15528, pp vp) **Tunable-diode laser absorption spectrometry.** Schiff, H. I. Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

Tunable-diode laser absorption spectrometry (TDLAS) affords a number of advantages for atmospheric measurements. It is a universal method, applicable, in principle, to all gases of atmospheric interest. Because of its extremely high spectral resolution it provides unequivocal identification of the target species, with no interferences from other gases. It provides real-time, in situ measurements with time resolutions better than 1 minute. The sensitivity of the current TDLAS system is marginally capable of measuring HO_2. This species exists in the troposphere at concentrations which are up to 2 orders of magnitude higher than those of HO and, in addition, is much less susceptible to removal by the surfaces of the instrument and its sampling system. HO_2 is an important HO/sub x/ species in its own right but can also give direct information on the HO concentration by virtue of the rapid partitioning between these two species. The addition of the high-frequency modulation technique to the TDLAS system would ensure its ability to measure HO_2 under most atmospheric conditions. The ability of the TDLAS to measure hydrogen peroxide (H_2O_2) in the ambient atmosphere was also demonstrated. H_2O_2 measurements give a clear indication of HO/sub x/ mixing ratios and are also important as a photolytic source of HO and as an important oxidant for other atmospheric consitituents such as SO_2.

25359 **(ORNL/TM—10295) Analysis of nitroguanidine in aqueous solutions by HPLC [high performance liquid chromatography] with electrochemical detection and voltammetry: Final report.** Manning, D.L.; Maskarinec, M.P. (Oak Ridge National Lab., TN (USA)). Apr 1987. Contract AC05-84OR21400. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007833.

This study was directed towards the analysis of nitroguanidine in aqueous solutions. Nitroguanidine, which is the strongest organic base known, is used in the manufacture of some explosives. A method based on reverse phase HPLC with reductive electrochemical detection was developed for the determination of low levels of nitroguanidine. The nitroguanidine can be concentrated in the aqueous solutions by rotary evaporation at 50°C. If the samples are not too complex, the nitroguanidine can be measured directly by voltammetry. From voltammetry, it was established that nitroguanidine is reduced via an irreversible diffusion controlled four electron process. 15 refs., 2 figs., 3 tabs.

25360 **(ORNL/TM—10348) An information retrieval system for chemical separations scientists.** Corey, B.B.; Gove, N.B.; Yount, S.L.; McDowell, W.J. (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007805.

Retrieving information on chemical separations is difficult because the literature is scattered among many branches of science; methods are often buried in articles dealing mainly with other topics; existing information services, such as Chemical Abstracts, do not index articles reliably by separation method; and separation method terminology is not consistent across disciplines. Attempts to solve problems of information retrieval in separations science have led to the concept of a Separations Science Data Base. In a cooperative effort, chemical separations scientists and computer analysts have developed a novel concept for supporting separations science data on a very large on-line information retrieval system that was developed primarily for bibliographic data. The system supports unique indexing techniques that provide rapid and accurate access to information about specific separations from specific matrices and minimize false returns that result from cross coupling of unrelated terms in multisubject reports. This data base is uniquely useful to separation scientists because, by the use of appropriate combinations of terms from selected fields, information on separations under specific conditions can be retrieved. These fields include separation system, separated substance, separation agent, matrix, and type of information. The computer system design and the creative approach to structuring of the separations science data are complementary with respect to data entry and indexing, information retrieval, and the various ways in which the results can be displayed at the user's terminal or microprocessor.

25361 **(PB—87-148706/XAB) Analysis for polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) in human adipose tissue: method evaluation study. Final report.** Stanley, J.S.; Ayling, R.E.; Bauer, K.M.; McGrath, M.J.; Sack, T.M. (Midwest Research Inst., Kansas City, MO (USA)). 17 Sep 1986. 149p. NTIS, PC A07/MF A01.

The report focuses on the evaluation of an HRGC/MS analytical method for determination of 2,3,7,8-substituted polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) in human adipose tissue. This method will be used for analysis of samples from EPA's National Human Adipose Tissue Survey (NHATS) as part of a collaborative effort between EPA's Office of Toxic Substances and the Veterans Administration. The method was evaluated using aliquots of a bulk lipid matrix that was extracted from human adipose tissue. The results of the replicate analysis of spiked and unspiked homogenized human adipose tissue matrix demonstrate that the analytical method produces accurate and precise data for 17 specific 2,3,7,8-substituted PCDD and PCDF (tetra- through octachlorohomologs) congeners. The endogenous or background levels of the PCDD and PCDF congeners in the homogenized adipose lipid matrix were estimated through regression analyses of measured versus spiked concentrations for each compound. This unspiked matrix will be used as a control sample with each batch of samples analyzed.

25362 **(UCRL—95861) Compaction of non-consolidated HMX beds.** Costantino, M.; Tao, W. (Lawrence Livermore National Lab., CA (USA)). 24 Mar 1987. Contract W-7405-ENG-48. 16p. (CONF-870394—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007445.

From Joint Army, Navy, NASA, Airforce propulsion systems hazards meeting; Huntsville, AL, USA (17 Mar 1987).

We present experimental data for the hydrostatic compaction to 50 MPa of non-consolidated beds of HMX. The starting material consists of the standard Class A, Class D, and Class E specifications, as well as the sieve cuts at 100 to 125 and 425 to 500 microns. We measure the hydrostatic pressure-volume relation for each sample along a loading and unloading path to 10, 30, or 50 MPa, then recover the sample in the last three sizes to obtain the final particle size distribution. The experiments are made using a classic bellows piezometer technique, with pressurization rates of about 0.1 MPa/s at room temperature. The P-v data support the classical picture of compaction of non-consolidated beds, in which particles move and rotate to fill voids at low external stress. At higher stresses, the compaction behavior is a function of the particle size distribution. For monomodal distributions, there is extensive fracture of the mode size, followed by fracture of the sizes best able to fit into voids created by the mode size. For multimodal distributions, this mechanism is not present to as large an extent, with agglomeration being the dominant behavior in Class E compaction. We find about a 2% sample-to-sample variation in the relative density. Measurable differences in the P-v curves of all size distributions below about 75% TMD become small at higher relative densities. The details of the low pressure curves depend most strongly on the initial particle packing and the type of size distribution (mono- or multi-modal). 23 refs., 12 figs., 1 tab.

25363 **(UCRL—95924) Lamella settlers: Material balances and clarification rates.** Maimoni, A. (Lawrence Livermore National Lab., CA (USA)). 1987. Contract W-7405-ENG-48. 22p. (CONF-870323—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006427.

From American Institute of Chemical Engineers spring national meeting; Houston, TX, USA (29 Mar 1987).

The material balances and clarification rates of a lamella settler can be obtained from the particle size distribution and density of the solid, the liquid density and viscosity, the desired solids concentration in the overhead product, and the feed and underflow solids concentration, using an algorithm based upon a simple geometric model. The method was validated using concentrated suspensions (up to 20 vol % solids) of four different feed particle size distributions of hydrargillite (aluminum hydroxide) in water. Most of the data were obtained in a 60-cm-long settler with 1-cm plate separation inclined at 60° to the horizontal in "open bottom" and "normal" configurations. The hydrodynamics of tube settlers are more complex and the algorithm is not applicable.

25364 **Application of a gas sampling introduction system for inductively coupled plasma spectroscopy and analyses of various plasma gases.** Mautz, K.E.; Parsons, M.L.; Moore, C.B. (Department of Chemistry, Arizona State University, Tempe, Arizona 85281; Motorola Semiconductor Products Sector, Mesa, Arizona 85202 (KEM)). *Applied Spectroscopy;* **41**: No. 2, 219-226(Feb 1987).

An inductively coupled plasma spectrometer was modified for gaseous sample introduction. The system uses a gas proportioner utilizing rotameters to achieve sample gas concentrations and mixing the sample argon gas. Modifications of instruments were performed to enhance stability and compatibility of gaseous sample introduction. Instrument performance was characterized for optimization of spectral signals produced from plasma gases. Spectral analyses of gaseous samples including CF_4, SF_6, O_2, N_2, air, and mixtures of CF_4-O_2 and CF_4-O_2/N_2 were performed. Identification of plasma gas and plasma-induced byproducts, both atomic and molecular, were determined.

25365 (N—87-15285) Automation of preparation of nonmetallic samples for analysis by atomic absorption and inductively coupled plasma spectrometry. Wittmann, A.; Willay, G. Translated from *Cahiers d'Informations Techniques/Revue de Metallurgie ;* **82**: No. 5, 399-410(Aug 1986). 26p. (NASA-TM—88476; NAS—1.15:88476). NTIS, PC A03/MF A01.

For a rapid preparation of solutions intended for analysis by inductively coupled plasma emission spectrometry or atomic absorption spectrometry, an automatic device called Plasmasol was developed. This apparatus used the property of nonwettability of glassy C to fuse the sample in an appropriate flux. The sample-flux mixture is placed in a composite crucible, then heated at high temperature, swirled until full dissolution is achieved, and then poured into a water-filled beaker. After acid addition, dissolution of the melt, and filling to the mark, the solution is ready for analysis. The analytical results obtained, either for oxide samples or for prereduced iron ores show that the solutions prepared with this device are undistinguished from those obtained by manual dissolutions done by acid digestion or by high temperature fusion. Preparation reproducibility and analytical tests illustrate the performance of Plasmasol.

25366 Fiber-optic sensors using Forster energy transfer. Roe, J.; Hirschfeld, T.B.; Burks, W.; Miller, H. (Lawrence Livermore National Lab., P.O. Box 808, Livermore, CA 94550). pp 390 of Proceedings of the conference on lasers and electro-optics. Washington, DC; Optical Society of America (1986). (CONF-860622—).

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

The energy transfer optrode allows a colorimetric reagent to turn a fluorescent transducer on and off using radiationless Forster transfer when the absorption spectrum overlaps that of the selected fluorescent material, and they are within —60 A distance. Resonant energy transfer has greatly advanced the versatility of remote sensor design. It combines the advantages of the general availability of colorimetric reagents with the convenience of fluorescent measurements. The results are greater sensitivity, a larger dynamic range, more stable chemicals in the sequestered environment, and the use of a single-ended fiber setup. In addition to these advantages, an increase in the interaction cross section due to the Forster radiationless transfer process produces a 1000X sensitivity enhancement over the trivial reabsorption of light. This allows a small concentration of the absorbent material, that is now the active agent, to pronouncedly affect the signal of a larger concentration of fluorescent material. An optrode for H/sub 2/S based on the use of lead sulfide and its black sulfide product in the presence of the target chemical is used as an example for the discussion of the physics and optimization of this type of optrode. Other optrodes that are described include (1) an NO/sub x/ sensor using a diazonium generating reagent that binds the fluorescent dye and interacts with its surrounding neighbor dye molecules, and (2) a K/sup +/ (NA/sup +/) sensor based on the color changes of Takagi reagent (a crown ether picric acid derivative) in the presence of the potassium ion, combined with a fluorescent sensing dye.

25367 Measurement of the properties of a CO_2 laser induced air-plasma by double floating probe and spectroscopic techniques. Radziemski, L.J.; Cremers, D.A.; Niemczyk, T.M. (New Mexico State Univ., Las Cruces). *Spectrochimica Acta, Part B: Atomic Spectroscopy;* **40B**: No. 3, 517-525(1985).

The laser-induced breakdown spark has recently been advanced as a method for real-time, in-situ spectrochemical analysis of gases. Many of these analyses take place in ambient air. To better characterize this source, they have measured the temporal variation of temperature and electron density in an air plasma induced by a CO_2 laser operating at 0.5 and 0.8 J/pulse. The electron temperature was measured by the double floating-probe technique (DFP). An excitation temperature for oxygen atoms was determined spectroscopically by Boltzmann plots. Electron density in the plasma was measured from the Stark broadening of the 715.6-nm line of 0 I. At 0.5 J/pulse, the DFP temperature ranged from 175,000 K at 5 μs to less than 10,000 K at 25 μs, while the 0 I excitation temperature ranged from 19,000 K at 1 μs to above 11,000 K at 25 μs. The excitation temperature and electron density agree with values calculated by others from local thermodynamic equilibrium models of an air plasma. While the electron temperature from the DFP method is much higher than the excitation temperature at 5 μs, at times greater than 25μs the two have converged, implying thermodynamic equilibration between the species. 25 references, 6 figures, 3 tables.

25368 One-atom detection and statistical studies with resonance ionization spectroscopy. Payne, M.G.; Hurst, G.S. (Oak Ridge National Lab., TN). pp 189-195 of Analytical laser spectroscopy. Martellucci, S.; Chester, A.N. (eds.). New York, NY; Plenum Publishing Corporation (1985). Contract W-7405-ENG-26.

In this lecture the authors wish to review how the laser made possible the counting of atoms and how this capability has been put to use in situations where atoms are free to react chemically as they diffuse through a medium. Fluctuation phenomena and statistical mechanics can also be examined in these situations. 16 references, 3 figures.

25369 Reliability of the quantification of eels measurements. Sklad, P.S.; Bentley, J.; Angelini, P.; Lehman, G.L. (Oak Ridge National Lab., TN). pp 285-288 of Analytical electron microscopy. Williams, D.B.; Joy, D.C. (eds.). San Francisco, CA; San Francisco Press, Inc. (1984). Contract AC05-84OR21400.

Over the past few years at ORNL a significant effort has been expended on developing the transition metal boride TiB_2 for applications that take advantage of its high hardness, high melting point, and chemical inertness. The major portion of this work has centered on the TiB_2-Ni system. AEM has been used extensively to provide microstructural information for structure-property correlations. Particular emphasis has been placed on identifying phases that develop during high-temperature exposure. Because of the presence of boron and other low-atomic-number elements in these materials, electron energy loss spectroscopy (EELS) has been an important tool in these investigations. However, repeated analyses of secondary phases, as well as of TiB_2 itself, lead to the conclusion that compositions determined by quantification of EELS spectra with the use of both K and L ionization edges were suspect. In an earlier paper the authors presented some of these results and suggested that the problem might lie in the computation of cross sections for L absorption edges. Since that time our interest in this problem has continued and the authors have concentrated on identifying the source of the inaccuracy with greater certainty. 12 references, 3 figures.

25370 (UCRL-Trans—12169) Potentiometric determination of organic sulfur using sodium tetraphenylborate as a titrant. Yu, Kuqin; Wang, Kemin; Zhou, Xinmin. Translated from *Fenxi Huaxue ;* **11**: No. 5, 343-347([1982]). Contract W-7405-ENG-48. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007762.

The potentiometric determination of sulphur in organic compounds has been studied. After combustion in an oxygen flask the resulting sulphate ions are precipitated by barium acetate, the excess of barium ions being titrated with sodium tetraphenylborate in the presence of polyethylene glycol (PEG). A number of PEG and PEG type nonionic surfactants have been compared as the complex-forming agent for barium ions, PEG 1540 being recommended as especially suitable for this purpose. The solubility of the precipitates was measured by uv spectrophotometry and the composition of some complexes was studied by potentiometric titration. The influence of molecular weight of PEG on the form of titration curves was interpreted by considering the solubility effect and complex composition. A tetraphenylborate ion electrode prepared from hexadecyltrioctylammonium tetraphenylborate as well as a silver sulphide electrode can be used as indicator electrodes. The mechanism of end point indication by the silver sulphide electrode was discussed. 9 refs., 4 figs., 3 tabs.

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REFER ALSO TO CITATION(S) 24393, 24402, 24403, 24409, 24437, 24540, 24609, 24677, 25212, 25280, 25303, 25418, 25435, 25914, 26096

25371 (BNL—38959) Adhesion properties of polyelectrolyte-chemisorbed zinc phosphate conversion coatings. Sugama, T. (Brookhaven National Lab., Upton, NY (USA)). Oct 1986. Contract AC02-76CH00016. 13p. (CONF-870410—14). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005262.

From 193. national meeting of the American Chemical Society; Denver, CO, USA (5 Apr 1987).

It has been reported that when mild carbon cold-rolled steels are immersed in the $Zn_3(PO_4)_2$. $2H_2O$-H_3PO_4-H_2O solution systems, the surface microfeatures of crystalline zinc phosphate (Zn . Ph) conversion coating deposited on the steel substrate surface were characterized by large rectangular-like crystal arrays of insoluble Zn . Ph hydrate. Deformation failures of layers having low stiffness characteristics appear to be directly related to the development of micropores and fissures which reduce the effectiveness of the corrosion-resistant coatings. Thus, it is necessary to increase the flexural modulus of the layers in order to restrain the physical deformation failures of the crystalline precoats. The brittle characteristics of the Zn . Ph can be modified by the introduction of the polyacrylic acid (PAA) macromolecules into the phosphating solutions. The incorporation of PAA, which is generally expressed as a polyelectrolyte macromolecule, was shown to form a highly dense fine crystal topography, suggesting that the crystal formation results in an improvement in the stiffness and ductility characteristics of the normally brittle Zn . Ph layers. Accordingly, emphasis of the present paper is given to the finding as to how the molecular structures and functional species of polyelectrolytes act to suppress crystal growth of Zn . Ph and improve interfacial bond durability of Zn . Ph-to-polymeric adhesive joints. 2 refs., 5 figs.

25372 (CONF-860229—1) Design and control of tubular autothermal reactor: An evolutionary approach. Chylla, R.W. Jr.; Adomaitis, R.A.; Cinar, A. (Illinois Inst. of Tech., Chicago (USA). Dept. of Chemical Engineering). 1986. Contract FG02-84ER13205. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006921.

From American Institute of Chemical Engineers winter national meeting; Miami, FL, USA (9 Feb 1986).

A systematic procedure for the design of a reactor system and controller for an autothermal process is proposed. Use of Structural Dominance Analysis eliminates the need for many detailed simulation runs to determine best reactor and controller configuration. Multistage wall-cooled reactors with cocurrent coolant are found to be a superior design. Reactor control is achieved using cold feed bypass gas to regulate in inlet temperature to each reactor bed. A controller is designed using the Internal Model Control structure. Performance and robustness are investigated using a first-order diagonal filter. 15 refs.

25373 (CONF-860425—42) Promotion by Cs(I) and poisoning by T1(I) of the Cu/ZnO catalysts for methanol synthesis and the water gas shift reaction. Bybell, D.G.; Deutsch, P.P.; Herman, R.G.; Himelfarb, P.B.; Nunan, J.G.; Young, C.W.; Bogdan, C.E.; Simmons, G.W.; Klier, K. (Lehigh Univ., Bethlehem, PA (USA)). 1986. Contract AC22-84PC70021;FG22-83PC60786. 10p. NTIS, PC A02. File Number DE87008133.

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

In the present work, the effects of univalent thallium, the solution chemistry of which is in many respects identical to that of the heavy alkali Rb and Cs ions, utilized as a dopant in the Cu/ZnO catalyst has been investigated. However, it is noted that the high temperature chemistry of T1(I) is more complex than that of the alkali ions in that the counterions of the T1(I) ion decompose more easily than those of the alkali ions and that T1(I) can be oxidized to T1(III) under certain conditions. We present evidence that the effects of the T1(I) dopant on the Cu/ZnO catalysts, in surface concentrations comparable to those of the most effective Cs(I) promoter, on both methanol synthesis and the Water Gas Shift (WGS) reaction, are diametrically opposite to those of the alkali metal ions. Indeed, the T1(I) ions behave rather as nearly inert additives for the WGS reaction, as a mild poison for methanol synthesis in the absence of H_2O or CO_2 in the synthesis gas, and as a severe poison for methanol synthesis in a ternary $H_2O/CO/H_2$ synthesis gas. The analysis of the results indicates that the hydrogen activating sites are poisoned by the thallium ions. 15 refs., 6 figs., 3 tabs.

25374 (DOE/ER/13104—2) Organometallic surface chemistry: Final report for period July 1, 1983-September 14, 1986. Shriver, D.F. (Northwestern Univ., Evanston, IL (USA). Dept. of Chemistry). Mar 1987. Contract AC02-83ER13104. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006812.

Most of our research was directed toward the role of promoters in heterogeneous CO hydrogenation and in hydroformylation reactions. It was found that the addition of Zn to a Rh/SiO_2 hydroformylation catalyst influences the ratio of hydroformylation to ethylene hydrogenation. A maximum is selectivity toward the oxygenated products was observed at a mole ratio of 0.05 Zn/Rh. Some possible roles of zinc are site blocking and an increased rate of CO insertion by Zn(II)-OC interactions. The latter type of interaction is known to promote CO insertion in organometallic compounds. In a second area of research, CCO has been characterized by vibrational spectroscopy in $[Ru_3(CO)_9(CCO)]^{2-}$. Analogy with molecular cluster chemistry suggests that CCO is likely to form on carbided closest packed metal surfaces and vibrational spectroscopy is a promising tool for testing this postulate.

25375 (DOE/ER/13150—3) Laser studies of chemical dynamics at the gas-solid interface: Progress report. Cavanagh, R.R.; King, D.S. (National Bureau of Standards, Washington, DC (USA). Center for Chemical Physics). 9 Sep 1986. Contract AI05-84ER13150. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005950.

Experiments during this period have focused on the thermal desorption of NO from Pt(111). Emphasis was placed on the relative importance of adsorbate-substrate vs adsorbate-adsorbate interactions. Both mass spectrometric and laser diagnostic techniques were used. The influence of coadsorption of CO was studied. Laser-induced thermal desorption of NO from platinum foil was studied.

25376 (DOE/ER/13296—3) Ligand transformations and catalysis by transition metal cluster compounds containing sulfur: Progress report, 1986. Adams, R.D. (South Carolina Univ., Columbia (USA). Dept. of Chemistry). Feb 1987. Contract FG09-84ER13296. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006733.

The following are reported: tertiary amine metathesis catalysis by metal carbonyl clusters containing carbene ligands, studies of the synthesis and transformations of carbene ligands in cluster complexes, transformations of hydrocarbyl ligands bonded to sulfur in polynuclear metal carbonyl complexes, and synthesis of sulfido ruthenium carbonyl complexes containing acetylene ligands and their reactions with small molecules.

25377 (DOE/ER/13362—2) [Theoretical and experimental investigations of fluctuation thermodynamic properties of liquid solutions]: Technical progress report for 15 April 86-14 April 87. O'Connell, J.P. (Florida Univ., Gainesville (USA)). 1987. Contract FG05-85ER13362. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005681.

Work has continued in the three activities of theory, correlation, and experiment. Results have been made for the thermodynamic properties of both nonelectrolyte and electrolyte liquids. (DLC)

25378 (DOE/ER/13411—1) Ligand intermediates in metal catalyzed reactions: Technical report, Second budget year. Gladysz, J.A. (Utah Univ., Salt Lake City (USA). Dept. of Chemistry). 1 Apr 1987. Contract FG02-85ER13411. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007740.

Progress during this period is reported on: chiral coordinatively unsaturated complexes, electrochemistry of organometallic complexes, hydride abstraction from alkyl ligands, stoichiometric oxidation of alkyl complexes, heterobimetallio CO_2 complexes, and structure of formyl and acyl complexes. (DLC)

25379 **(DOE/ER/13590—1) Multiphoton ionization spectroscopy and photochemistry of transient species: Annual progress report for period July 15, 1986-July 15, 1987.** Johnson, P.M. (State Univ. of New York, Stony Brook (USA)). Jul 1987. Contract FG02-86ER13590. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006422.

During this initial year of our grant period we have continued our studies of the excited states of metastables and radicals, primarily focusing on extending our work on nitrogen molecule triplet states and the excited states of the carbon chloride molecule. We have also been involved in considerable construction of new apparatus in order to increase the power and versatility of our experimental program.

25380 **(DOE/ER/13604—1) Study of synthesis gas conversion over metal oxides: Progress report, August 1, 1986-July 31, 1987.** Ekerdt, J.G. (Texas Univ., Austin (USA). Dept. of Chemical Engineering). Mar 1987. Contract FG05-86ER13604. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007768.

The goals of this program are (1) identification of the reaction intermediates present during CO hydrogenation reactions, (2) determination of the reaction pathways whereby the intermediates are converted into products and (3) the development of an understanding of the causes for catalytic activity and selectivity. Direct CO hydrogenation into branched alkanes and aromatics, isosynthesis, is being investigated over zirconium dioxide and alkali-promoted zirconium dioxide. Reaction mechanisms have been identified by use of infrared spectroscopy, temperature-programmed reaction techniques, and carbon-13 and oxygen-18 isotope labeling. Chain propagation proceeds by CO insertion into adsorbed aldehyde/ketone species and by a condensation reaction between methoxide and enolate species. Current, and future, research is focusing on these chain growth reactions and is directed toward establishing how acid and base promoters affect the absolute rate of these invididual reactions. The active site for CO activation was suggested, on the basis of oxygen-18 studies, to be an anion vacancy. The role of anion vacancies in Co hydrogenation is currently under investigation.

25381 **(DOE/ER/45120—5) The use of surface characterized dispersed metal catalysts in catalytic reactions: Progress report for period September 1, 1984-January 1, 1987.** Augustine, R.L. (Seton Hall Univ., South Orange, NJ (USA). Dept. of Chemistry). 15 Jan 1987. Contract FG02-84ER45120. 11p. NTIS, PC A02. File Number DE87006811.

The Single Turnover (STO) catalyst characterization procedure has been applied to a number of different metal/support combinations other than Pt/CPG and these characterized catalysts have been used in several catalytic studies. In one of these a correlation was made with Pt single crystal catalytic data which showed that the STO saturation sites on dispersed Pt catalysts are probably corner atoms. Using series of STO characterized catalysts in steady state hydrogenations has also led to the determination of a turnover number for each of the three different types of saturation sites present. 21 refs.

25382 **(DOE/ER/45122—T1) Metallic glasses as new catalyst systems for energy conversion: Final report.** Brower, W.E. Jr.; Smith, G.V. (Southern Illinois Univ., Carbondale (USA)). [1987]. Contract FG02-84ER45122. 87p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007753.

Pd-Si metallic glasses have been utilized as catalysts in the Fischer-Tropsch reaction. The glasses are selective of ethane, whereas the in-situ crystallized glasses select a range of hydrocarbons characteristic of conventional Pd catalysts. This shift in selectivity has been observed in other hydrogenation reactions. Surface crystallization caused by the reaction conditions causes variable selectivity. Crystallization in reaction conditions has been monitored by DSC. During the course of the grant we developed the use of (+)- apopinene (6,6-dimethyl-1R,5R-bicyclo[3.1.1]hept-2-ene) as a molecular probe for determining the number and kinds of active sites on metallic glass catalysts. To accomplish this we conducted many experiments for comparison on other types of catalysts. These were foils, powders, and highly dispersed metals on several different supports. The glassy surfaces appear to be three dimensionally random (hilly or rolling) with many protuberances which crystallize into staircases of steps and kinks. 94 refs., 29 figs., 5 tabs.

25383 **(DOE/ER/45259—1) Band electronic structures and crystal packing forces of ET salts: Progress report, July 1, 1986-February 28, 1987.** Whangbo, M.H. (North Carolina State Univ., Raleigh (USA). Dept. of Chemistry). Mar 1987. Contract FG05-86ER45259. 4p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007407.

This report describes our research progress for the period of July 1, 1986-February 28, 1987. Our progress has been made in several aspects of our research on organic conducting salts, and we have recently initiated our research in the area of high T/sub c/ superconductors La/sub 2-x/M/sub x/CuO_4 (M = Ba, Sr; x ≃ 0.15). In our report, the acronyms MT, ET and PT refer to the organic donor molecules BMDT-TTF, BEDT-TTF and BPDT-TTF, respectively. 9 refs.

25384 **(DOE/NV/10354—T1) Evaluations and use of saturation index values to predict scale formation: Annual report.** McDonald, C.; Murty, V.S. (Texas Southern Univ., Houston (USA)). Nov 1986. Contract AS07-83NV10354. 28p. NTIS, PC A03. File Number DE87006798.

Scaling is a significant problem in the oil, gas, and water industries. The most commonly occurring mineral deposits in scaling are $CaCO_3$, $CaSO_4$, $BaSO_4$, and $SrCO_3$. In this study, effects of alkaline earth metals and sulfate ions on $CaCO_3$ precipitation has been studied at high temperatures and pressures.

25385 **(DOE/PC/70782—11) Electron spin mapping of coal molecular structure by ENDOR [electron nuclear double resonance]: Quarterly technical progress report.** Belford, R.L. (Illinois Univ., Urbana (USA)). 15 Apr 1987. Contract FG22-84PC70782. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008390.

ENDOR and x-band EPR spectra were obtained for solutions of perylene in benzene or d6-benzene onto an activated alumina or silica-alumina surface. The investigators believe that their matrix ENDOR observations show the radical sites for perylene adsorbed on their particular alumina and silica-alumina surfaces to be different. The data indicate that on the alumina the radical has stronger interactions and/or less mobility relative to the frozen solvent than it does on the silica-alumina. Their alumina surface is marked by spectroscopic evidence of the ubiquitous proton while their silica-alumina is not. Finally, the perylene radical on their alumina rests near at least one aluminum atom; the typical detection range of matrix ENDOR is limited to within 5 to 6 angstroms. Conversely, the aluminum-27 resonance is never observed with our Houdry M-46 silica-alumina material. Even considering that their Houdry catalyst contains only 10% of the aluminum in alumina and the inherent lack of matrix intensity on this surface, they would still expect to detect a weak aluminum-27 resonance at liquid helium temperature on purely statistical grounds. Its absence indicates a preference of the perylene radical for a site near an aluminum atom on their alumina, and/or the lack of a preference for an "alumina-type" site in the Houdry M-46 silica-alumina. They conclude that observation of matrix ENDOR features has proven to be a valuable complementary tool in the study of radicals adsorbed on metal oxide surfaces. 18 refs., 7 figs., 1 tab.

25386 **(DOE/PC/90009—1) Evaluation of direct methane conversion to higher hydrocarbons and oxygenates: Quarterly report for the period 1 October-31 December 1986.** Kuo, J.C.W. (Mobil Research and Development Corp., Paulsboro, NJ (USA)). Jan 1987. Contract AC22-86PC90009. 72p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006665.

In this first report of the project, a project work plan has been prepared and the task on information gathering and preliminary evaluation of the methane direct conversion processes was initiated. A detailed classification of the direct conversion processes was structured for the convenience of information gathering and later evaluation. An extensive literature search was completed. Literature review and some preliminary evaluation have also been carried out. 386 refs.

25387 **(DOE/SR/14014—3) Solubility products and thermodynamic functions for the lanthanon fluoride water-systems: Technical progress report.** Menon, M.P. (Savannah State Coll., GA (USA). Dept. of Chemistry). Mar 1987. Contract FG09-84SR14014. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007878.

The solubility and the solubility product of GdF_3 were remeasured using both conductometric and potentiometric methods after careful washing of the precipitate and drying. Radiometric techniques were also employed for the measurement of the solubility of both GdF_3 and SmF_3. In addition solubilities of the ytterbium trifluoride (YbF_3) and praseodymium trifluoride (PrF_3) were measured by conductometric method as a function of temperature. The measurement of the solubility of YbF_3 by radiochemical technique was completed.

25388 **(EPRI-AP—5119) Mutual solubilities and vapor pressures for binary and ternary aqueous systems: Final report.** Anderson, F.; Prausnitz, J. (Lawrence Berkeley Lab., CA (USA); California Univ., Berkeley (USA). Dept. of Chemical Engineering; Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1987. Contract AC03-76SF00098. 31p. NTIS, PC A03/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1; GPO Dep. File Number DE87008008.

An apparatus has been constructed for measuring mutual solubilities and vapor pressures for aqueous-organic liquid-liquid systems in the region ambient to 200°C. Both liquid phases are sampled and analyzed using gas chromatography. Special care must be taken to assure reliable sampling because mutual solubilities are very small; it is especially important to avoid entrainment, phase change (due to temperature gradients or pressure drop) and adsorption when removing samples for chemical analysis. Experimental results are reported for the temperature range 100 to 200°C for binary aqueous mixtures containing benzene, toluene, m-xylene, and thiophene, and for ternary aqueous mixtures containing benzene and pyridine. The binary results are in good agreement with diverse data reported in the literature. 10 refs., 7 figs., 5 tabs.

25389 **(LA/Sub—D6927H-2) Equation of state of ice.** (Ktech Corp., Albuquerque, NM (USA); Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005784.

From July through December 1987, Ktech provided support to Los Alamos National Laboratory in the area of the equation of state of ice. This work consisted of attendance at the International Symposium on the Physics and Chemistry of Ice, timely transmittal of equation of state information obtained there, and modelling to the temperature dependence of the specific heat of ice I/sub h/. The key findings reported at the symposium were acoustic velocities at high pressure of ices I/sub h/, II, III, V and VI. The specific heat modeling demonstrated the importance of anharmonic effects, especially at temperatures above about two thirds of the melting temperature. 20 refs., 1 fig., 2 tab.

25390 **(LBL—21662) Reaction paths and surfaces for hydrogen atom transfer reactions in polyatomic molecules.** Miller, W.H. (Lawrence Berkeley Lab., CA (USA)). May 1986. Contract AC03-76SF00098. 13p. (CONF-8605149—2). NTIS, PC A02. File Number DE87006148.

From 19. Jerusalem symposium on quantum chemistry and biochemistry; Jerusalem, Israel (5 May 1986).

The reaction path/surface Hamiltonian model for polyatomic reaction dynamics is reviewed. Applications to formaldehyde decomposition ($H_2CO \rightarrow H_2 + CO$), vinylidene isomerization ($H_2C = C: \rightarrow HC$ idential to CH), and intramolecular H-atom transfer in malonaldehyde show that tunneling effects play an important role in these processes. 18 refs., 6 figs.

25391 **(LBL—21859) Documentation for computer code NACL.** Weres, O.; Peiper, J.C.; Pitzer, K.S.; Pabalan, R. (Lawrence Berkeley Lab., CA (USA)). Feb 1987. Contract AC03-76SF00098. 34p. NTIS MF A01; 2; GPO Dep. File Number DE87007906.

The computer program NACL incorporates the empirical model of the thermodynamic properties of the system $NaCl-H_2O$ recently published by Pitzer et al. NACL is derived from the research codes used by Pitzer et al. to analyze the experimental data and fix the parameters in their model. NACL calculates values for all thermodynamic properties which are identical to values tabulated in Ref. 1. NACL is written in VAX/VMS FORTRAN, and was developed on a VAX 8600 computer. Machine specific features have been avoided, and NACL should require few changes to compile and run with other compilers and computers. A sample output and full code listing of NACL are appended to this document. For one year following the publication of this document, the code will be made available to interested users on 5.25" floppy diskette in MS-DOS 2.11 format. Please send a formatted diskette and a stamped, self-addressed mailer to Oleh Weres, Lawrence Berkeley Laboratory, 50E, Berkeley, CA 94720. Please put your name and address on the diskette.

25392 **(LBL—22089-Rev.) Comparison of polynuclear aromatic hydrocarbon cation salts with salts of simple fluoroaromatic cations.** Richardson, T.J.; Tanzella, F.L.; Bartlett, N. (Lawrence Berkeley Lab., CA (USA)). Feb 1987. Contract AC03-76SF00098. 21p. (CONF-860911—18-Rev.). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006943.

From 192. American Chemical Society national meeting; Anaheim, CA, USA (7 Sep 1986).

Electron oxidation of the fluoro-aromatics C_6F_6 and $C_{10}F_8$ by O_2^+ salts yields salts of the radical cations $C_6F_6^+$ and $C_{10}F_8^+$ which are Curie-Law paramagnets. The fluoro-analogs of the "metallic" $(C_{10}H_8)_2^+$ salts do not exist. Repulsive interactions involving the electron-rich fluorine ligands of the fluoro-aromatics are probably responsible for the failure of these species to make metallic stacks. Attempts to prepare $C_6H_6^+$ salts have given the poly(paraphenylene) cation salts (C_6H_4)/sub n/$^+ AsF_6^-$ which are good electronic conductors. Electron oxidation of polynuclear aromatics by $C_6F_6^+$ salts or by AsF_5, e.g., $3AsF_5 + 2C_{24}H_{12} \rightarrow 2C_{24}H_{12}^+AsF_6^- + AsF_3$, yields what appear to be salts of the polynuclear aromatic cations. The magnetic and electrical properties of such salts are described. 16 refs., 2 figs.

25393 **(LBL—22511) Vibrational spacings in molecular hydrogen.** Veirs, D.K.; Rosenblatt, G.M. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 5p. (CONF-860853—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003531.

From 10. international conference on Raman spectroscopy; Eugene, OR, USA (31 Aug 1986).

Spontaneous Raman spectroscopy is used to determine line positions of the six isotopomers of molecular hydrogen: H_2, HD, HT, D_2, DT and T_2. State population number densities as low as 1.3×10^8 cm^{-3} are detected with the present experimental apparatus. This sensitivity makes possible measurements of the first overtone Q-branch line positions for H_2 and D_2. The observed line positions are given.

25394 **(LBL—22578) References to ultraviolet photoelectron spectra of gaseous molecules.** Horne, D.H.; Jolly, W.L. (Lawrence Berkeley Lab., CA (USA)). Sep 1986. Contract AC03-76SF00098. 53p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007905.

This report consists of an alphabetical listing of compounds together with Chemical Abstracts references (for the years 1972-1985) to articles describing research in which these compounds are the subject of gas-phase ultraviolet photoelectron spectroscopic studies. The Chemical Abstracts citations are copyrighted by the American Chemical Society and are reproduced here with their permission.

25395 (N—87-15528) **Future directions for H/sub x/ O/sub y/ detection.** Crosley, D. R.; Hoell, J. M. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Dec 1986. 67p. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.). NTIS, PC A04/MF A01.

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

The activities and recommendations of the NASA workshop on the Future Directions for H/sub x/ O/sub y/ detection are given. The objective of this workshop was to access future directions for the measurement of the OH radical as well as other H/sub x/ O/sub y/ species. The workshop discussions were focused by two broad questions: (1) What are the capabilities of potential measurement methods? and (2) Will the results from the most promising method be useful in furthering understanding of tropospheric chemistry?

25396 (N—87-15528, pp vp) **Executive summary.** Dec 1986. NTIS, PC A04/MF A01. (NASA-CP—2448; L—16216; NAS—1.55:2448; CONF-8508229—Exec.Summ.).

From Future directions for H/sub x/ O/sub y/ detection; Menlo Park, CA, USA (12 Aug 1985).

New methods for the measurement of OH radicals were assessed as were currently available and possible future methods for the other H/sub x/ O/sub y/ species, HO_2 and H_2O_2. The workshop participants were invited from different groups: modelers of atmospheric photochemistry, experimentalists measuring H/sub x/ O y species with laser and nonlaser methods, and chemists and physicists familiar with such experiments but not involved in atmospheric monitoring. There were three major conclusions from the workshop concerning the OH radical. First, it was felt that local measurements made by laser techniques would be ready within 2 or 3 years to furnish reliable measurements at the level of 1,000,000 cu. cm. Second, measurements at this level of sensitivity and with attainable levels of precision could indeed be used to make useful and interesting tests of the fast photochemistry of the troposphere. It is important, however, that the measurements be carefully designed, with respect to spatial and temporal averaging, if there is to be a meaningful comparison between results from two experimental methods or a measurement and a model. Third, nonlocal measurements using released reactants and tracers would also be very useful. These could be made on a regional or global basis, although they still require experimental design including choice of compounds.

25397 (N—87-16084) **Theoretical research program to study transition metal trimers and embedded clusters. Semiannual report, 1 July-31 December 1986.** Walch, S. P. (Eloret Corp., Sunnyvale, CA (USA)). Dec 1986. 80p. (NASA-CR—180138; NAS—1.26:180138). NTIS, PC A05/MF A01.

The calculation of potential energy surfaces for chemical reactions was the focus of investigation. Two groups of reactions were considered: the subset of reactions important in H_2 combustion, and high temperature air chemistry reactions ($O + N$ yields $NO + N$ and $N + O_2$ yields $NO + O$).

25398 (N—87-16084) **Extended active space CASSCF/MRSD CI calculations of the barrier height for the reaction: $O + H_2$ yields $OH + H$.** Walch, S. P. (Eloret Corp., Sunnyvale, CA (USA)). Dec 1986. 23p. (NASA-CR—180138; NAS—1.26:180138). NTIS, PC A05/MF A01.

The convergence of the barrier height for the $O + H_2$ yields $OH + H$ reaction was studied as a function of the size of the active space and basis set completeness. The barrier height is rapidly convergent with respect to expansion of the active space. Addition of 2p yields 2p' correlation terms to the active space lowers the barrier to the $O + H_2$ reaction by about 2.0 kcal/mole, but addition of 3d and other terms has little additional effect. Multireference singles and doubles contracted CI plus Davidson's correction calculations using a (5s5p3d2f1g/4s3p2d1f) basis set with a 5 sigma 2 pi active space lead to a barrier height of 12.7 kcal/mole. Including an estimate of the CI contraction error and basis set superposition error leads to 12.4 kcal/mole as the best estimate of the barrier height.

25399 (SAND—86-2535C) **Spin-cast carbon films from polyacrylonitrile.** Renschler, C.L.; Sylwester, A.P. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 2p. (CONF-870410—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002489.

From 193. national meeting of the American Chemical Society; Denver, CO, USA (5 Apr 1987).

Carbon films have been made by a variety of techniques, including evaporation, sputtering, and laser or thermal pyrolysis of organic polymers. Polyacrylonitrile (PAN) is often used as a carbon precursor, since low-temperature thermo-oxidative pretreatment produces a material which can be pyrolyzed without loss of shape. This is the basis for the production of carbon fibers with good mechanical properties. We report here the formation of very thin films of carbon (500 to 1500 A) by pyrolysis of spin-cast PAN. Using this technique, large, conductive films can be made which are sufficiently robust to allow intact lift-off and transfer of the films from one substrate to another. Such films are chemically inert, but can be photolithographically patterned and etched with an oxygen plasma.

25400 (SAND—86-2591C) **Isotactic polystyrene phase diagrams and physical gelation.** Aubert, J.H. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 11p. (CONF-870410—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002693.

From 193. national meeting of the American Chemical Society; Denver, CO, USA (5 Apr 1987).

Although the gelation of isotactic polystyrene (iPS) solutions has been studied for a long time, no prior attempt has been made to measure phase diagrams of these solutions. This is surprising because it has been suggested that gelation occurs by liquid-liquid phase separation and knowledge of the phase diagram could support this mechanism. In addition, it has long been known that iPS gels melt at a much higher temperature than where they form. No adequate explanation has been offered for this. We have determined one partial phase diagram for iPS/nitrobenzene(NB) solutions which has allowed us to relate the super-molecular structure of the physical gel to the characteristics of the phase diagram. This is important not only for an adequate explanation of physical gelation but in order to utilize such gels in the manufacture of microporous membranes and foams.

25401 (UCRL—96163) **A kinetic modeling study of n-pentane oxidation in a well-stirred reactor.** Westbrook, C.K.; Pitz, W.J.; Thornton, M.M.; Malte, P.C. (Lawrence Livermore National Lab., CA (USA); Washington Univ., Seattle (USA)). 24 Feb 1987. Contract W-7405-ENG-48. 32p. (CONF-870484—1). NTIS, PC A03/MF A01; GPO Dep. File Number DE87006377.

From Western states section/the Combustion Institute spring meeting; Provo, UT, USA (6 Apr 1987).

Oxidation of n-pentane in a well-stirred reactor is examined, using a numerical model and a detailed chemical kinetic reaction mechanism, including 53 chemical species and 325 elementary reactions. Temperatures studied range from 1068 K to 1253 K, and the pressure is atmospheric. The major reaction paths consuming n-pentane are H-atom abstraction by OH radicals, followed by H-atom abstraction by H and O atoms and the unimolecular decomposition to produce ethyl and n-propyl radicals. Logically distinguishable H atoms in n-pentane are treated separately, and decomposition of the three different types of pentyl radicals via β-scission is found to dominate over isomerization through internal H atom transfer or reaction with molecular oxygen. Computed and measured results for chemical species concentrations show substantial agreement at temperatures below 1200 K. However, at higher temperatures, the computed oxidation of the n-pentane is substantially more rapid than measured. In the experiments, n-pentane oxidation does not become so rapid as to cause a clear breakdown in reactor homogeneity until the temperature exceeds 1260 K. Explanations for this difference are discussed. 36 refs., 2 figs., 1 tab.

25402 **(UCRL—96404) Propene oxidation at low and intermediate temperatures: A detailed chemical kinetic study.** Wilk, R.D.; Cernansky, N.P.; Pitz, W.J.; Westbrook, C.K. (Drexel Univ., Philadelphia, PA (USA). Dept. of Mechanical Engineering and Mechanics; Lawrence Livermore National Lab., CA (USA)). 24 Mar 1987. Contract W-7405-ENG-48. 34p. (CONF-870484—2). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007449.

From Western states section/the Combustion Institute spring meeting; Provo, UT, USA (6 Apr 1987).

A detailed chemical kinetic mechanism for propene oxidation is developed and used to model reactions in a static reactor at temperatures of 575-715 K, equivalence ratios of 0.8 - 2.0, and a pressure of 600 torr. Modeling of hydrocarbon oxidation in this temperature range is important for the validation of detailed models to be used for performing calculations related to automotive engine knock. The model predicted induction periods and species concentrations for all the species and all conditions measured experimentally in the static reactor. Overall, the calculated concentrations of carbon monoxide, acetaldehyde, acrolein, and propane oxide agreed well with those measured. The calculated concentrations of ethane are low compared to the experimental measurements, and the calculated concentrations of formaldehyde are high. Agreement for concentrations of carbon dioxide, methane, and methanol is mixed. The characteristic s-shape of the fuel concentration history is well predicted. Modeling calculations identified some of the key reaction steps at the present conditions. Addition of OH to propene and H atom abstraction by OH from propene are important steps in determining the subsequent distributions of intermediate products, such as acetaldehyde, acrolein and formaldehyde. Allyl radicals are very abundant in propene oxidation, and the primary steps found to be responsible for their consumption are reaction with CH_3O_2 and HO_2. 37 refs., 5 figs., 1 tab.

25403 **(UCRL-Trans—12171) Novel dyes with bridged methines.** Shishido, Tadao. (Lawrence Livermore National Lab., CA (USA)). Mar 1987. Contract W-7405-ENG-48. Translation of Japanese Patent Application Kokai No. 61-57647, 24 March 1986. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007761.

A description is given of several novel dyes that have been produced. Next, a method for synthesizing the novel dyes is described followed by five examples of synthesis.

25404 **One-electron reduction of dihexadecyl phosphate vesicle bound viologens bypentacyanocobaltate(II) ions.** Husrt, J.K.; Thompson, D.H.P. (Oregon Graduate Center, Beaverton). *Inorganic Chemistry;* **26**: No. 1, 39-43(14 Jan 1987). Contract AC06-83ER13111.

N-Methyl-N'-alkyl-4,4;-bipyridinium (C/sub n/MV^{2+}) ions bound to dihexadecyl phosphate (DHP) vesicles are rapidly reduced to radical cations by $Co(CN)_5^{3-}$ in alkaline solutions containing cyanide ion. For the short-chain viologens investigated (n ≦ 10), the predominant pathway obeys the rate law d[C/sub n/MV^{+}]/dt = a[C/sub n/MV^{2+}]/(b + c[C/sub n/MV^{2+}]), where a is pseudo first order in [$Co(CN)_5^{3-}$] and [CN^{-}] under the experimental conditions. Reaction rates for longer chain viologens (n ≧ 14) are several-fold slower at comparable reactant concentrations; the kinetic traces are biphasic, with both components first order in [C/sub n/MV^{2+}] and pseudo first order in [$Co(CN)_5^{3-}$] and [CN^{-}]. A mechanism consistent with the data comprises outer-sphere electron transfer preceded by $Co(CN)_4^{3-}$ ligation of a sixth CN^{-} ion. This mechanism was confirmed for C_6MV^{2+}-DHP vesicles by quantitative isolation and spectrophotometric identification of $Co(CN)_6^{37}$ ion as the Co(III) product. The biphasic reduction of the long-chain viologens was taken as evidence for two distinct binding environments within DHP vesicles. The significance of these findings is discussed with the context of other studies on the dynamic properties of C/sub n/MV^{2+}-DHP particles. 25 references, 4 figures, 1 table.

25405 **Stereoselectivity as a probe of reaction mechanism in the oxidation of $[Co(en)_3]^{2+}$ and its derivatives by $[Co(edta)]^{-}$.** Osvath, P.; Lappin, A.G. (Univ. of Notre Dame, IN). *Inorganic Chemistry;* **26**: No. 1, 195-202(14 Jan 1987).

Stereoselectivities in the oxidations of $[Co(en)_3]^{2+}$, $[Co(sen)]^{2+}$, $[Co(sep)]^{2+}$, $[Co((+/-)\text{-}bn)_3]^{2+}$, and $[Co((+/-)\text{-}chxn)_3{}^{2+}$ by $[Co(edta)]^{-}$ have been examined under a variety of conditions. For the conformationally restricted complexes $[Co((+/-)\text{-}bn)_3]^{2+}$ and $[Co((+/-)\text{-}chxn)_3]^{2+}$ the stereoselectivity shows a trend from 15% ΔΔ for $[Co((+/-)\text{-}bn)_3\text{-}lel_3]^{2+}$ (25% ΔΔ for $[Co((+/-)\text{-}chxn)_3\text{-}lel_3]^{2+}$) to 25% ΔΔ for $[Co((+/-)\text{-}bn)_3\text{-}ob_3]^{2+}$ (16% Δ Lambda for $[Co((+/-)\text{-}chxn)_3\text{-}ob_3]^{2+}$. For $[Co(en)_3]^{2+}$, $[Co(sen)]^{2+}$, and $[Co(sep)]^{2+}$, stereoselectivities are 11% Δ Lambda, 10% Δ Lambda, and 18% Δ Lambda, respectively. Kinetic studies are consistent with outer-sphere reactions. The stereoselectivities are correlated with ion-pairing stereoselectivities for the interactions of $[Co(edta)]^{-}$ with the appropriate cobalt(III) amine complexes, supporting an important role for precursor complex structure in determining the chiral induction. The trends in the data are explained in terms of a balance of interactions along the C_2 and C_3 axes of the reductant complexes. 59 references, 5 figures, 4 tables.

25406 **X-ray and neutron diffraction study of the new cationic bis(hydrido)-bridged platinum-iridium complex $[(PEt_3)_2Pt(\mu\text{-}H)_2IrH_2(PEt_3)_2]^{+}[BPh_4]^{-}$.** Albinati, A.; Emge, T.J.; Koetzle, T.F.; Meille, S.V.; Musco, A.; Venanzi, L.M. (Brookhaven National Lab., Upton, NY). *Inorganic Chemistry;* **25**: No. 27, 4821-4827(31 Dec 1986).

The structure of $[(PEt_3)_2Pt(\mu\text{-}H)_2IrH_2(PEt_3)_2]^{+}[BPh_4]^{-}$ has been studied by X-ray and neutron diffraction techniques, at room temperature and 22 (1) K, respectively. At both temperatures, crystals of the title compound are monoclinic, with space group $P2_1/c$ and Z = 4. Unit cell parameters at 22 K are as follows: a = 18.989 (10) A, b = 15.314 (3) A, c = 19.792 (6) A, β = 118.73 (3)^0, and V = 5047 (4) A^3. The coordination around the Ir atom is distorted octahedral, while that around Pt is distorted square planar. The neutron analysis shows that the Pt-Ir distance is 2.677 (1) A and that the distances between the metals and bridging hydrido ligands differ by 0.15 A (Ir-H = 1.879 (3) and 1.882 (3) A; Pt-H = 1.726 (3) and 1.736 (3) A). The two terminal Ir-H bonds are equivalent (1.586 (3) and 1.591 (3) A) and comparable in length to those found in other neutron diffraction studies. 47 references, 1 figure, 4 tables.

25407 **(N—87-15525) Control of H_2S emissions using an ozone oxidation process: preliminary results.** Defaveri, D.; Ferrando, B.; Ferraiolo, G. Translated from *Chimica e l'Industria (Milan) ;* **67**: No. 9, 463-466(Sep 1986). 13p. (NASA-TM—88475; NAS—1.15:88475). NTIS, PC A02/MF A01.

The problem of eliminating industrial emission odors does not have a simple solution, and consequently has not been researched extensively. Therefore, an experimental research program regarding oxidation of H_2S through ozone was undertaken to verify the applicable limits of the procedure and, in addition, was designed to supply a useful analytical means of rationalizing the design of reactors employed in the sector.

25408 **Method for isotope enrichment of mercury-196 by selective photoionization.** Paisner, J.A.; Crane, J.K. (to Dept. of Energy). US Patent Application 6-898,084. 20 Aug 1986. 14p. Contract W-7405-ENG-48. DE87007210 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007210.

A method is provided for selectively photoionizing ^{196}Hg atoms in a vapor utilizing a three or four-step photoionization process.

25409 **Process for producing peracids from aliphatic hydroxy carboxylic acids.** Chum, H.L.; Palasz, P.D.; Ratcliff, M. (to Dept. of Energy). US Patent Application 6-863,897. 16 May 1986. 29p. Contract AC02-83CH10093. DE87007253 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007253.

A process is disclosed for producing peracids from lactic acid-containing mixtures derived from biomass processing systems. The process includes adjusting the pH of the mixture to about 8 to 9 to form an alkaline precipitate. The alkaline precipitate is then removed therefrom to produce a residual solution containing lower aliphatic hydroxy acids. The residual solution is then oxidized continuously to produce gaseous lower aliphatic aldehydes. The gaseous aldehydes are removed immediately as they are generated to prevent further oxidation to carboxylic acids and are then converted to peracids.

25410 **Catalysts for the production of hydrocarbons from carbon monoxide and water.** Sapienza, R.S.; Slegeir, W.A.; Goldberg, R.I. (to Dept. of Energy). US Patent Application 6-797,509. 6 Nov 1985. 10p. Contract AC02-76CH00016. DE87007273 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007273.

A method of converting low H_2/CO ratio syngas to carbonaceous products comprising reacting the syngas with water or steam at 200 to 350°C in the presence of a metal catalyst supported on zinc oxide. Hydrocarbons are produced with a catalyst selected from cobalt, nickel or ruthenium and alcohols are produced with a catalyst selected from palladium, platinum, ruthenium or copper on the zinc oxide support. The ratio of the reactants are such that for alcohols and saturated hydrocarbons: $(2n + 1) \geqq x \geqq O$ and for olefinic hydrocarbons: $2n \geqq x \geqq O$ where n is the number of carbon atoms in the product and x is the molar amount of water in the reaction mixture.

25411 **Triplet state: an example of G.N. Lewis' research style.** Kasha, M. (Florida State Univ., Tallahassee). *Journal of Chemical Education;* **61**: 204-215(Mar 1984). Contract AS05-78EV05855.

The research style and anecdotal accounts of work with G.N. Lewis are presented. Particular emphasis is placed on the work leading to the observation of molecular triplet states and singlet to triplet transitions in molecules with low Z atoms.

25412 **Polymer-supported phase transfer catalysts: Reaction mechanisms.** Ford, W.T.; Tomoi, M. (Dept. of Chemistry, Oklahoma State Univ., Stillwater, OK). pp 49-104 of Solar energy: Phase transfer catalysis, transport processes. New York, NY; Springer-Verlag New York Inc. (1984).

Polymer-supported phase transfer catalysts are insoluble polymers having covalently bound functional groups active as catalysts for reactions between anions and neutral organic substrates. The active functional groups may be quarternary ammonium or phosphonium ions, crown ethers, cryptands, grafted poly(ethylene glycols), or analogues of dipolar aprotic solvents. The polymer most often used is polystyrene, but other synthetic polymers, silica gel, and alumina have been used also. The reactions are carried out in triphase mixtures of organic liquid, solid or aqueous inorganic salt; and solid catalyst. The chemical reactions take place within the polymer matrix or on the polymer surface. With heterogeneous catalysts the reaction rate may be limited by mass transfer of reactants to the catalyst surface, intraparticle diffusion of reactants to the active sites, or intrinsic reactivity at the active sites. An analysis of the experimental parameters which affect catalytic activity and their mechanisms of action is presented.

25413 **Thermodynamics for processes in finite time.** Andresen, B.; Berry, R.S.; Ondrechen, M.J.; Salamon, P. (Univ. of Copenhagen, Denmark). *Accounts of Chemical Research;* **17**: 266-271(1984).

Thermodynamics serves several functions for chemistry and its sister sciences and technologies. The first of these historically, and still one of the most important, is the provision of limits on the performance of processes and devices. The very origins of thermodynamics developed from the creative ways people addressed the problem of how best to pump water out of mines. The provision of limits of performance is the main concern of the work they describe here. Research during the past 9 years has led to new ways of finding natural bounds on performance under the constraint that the system operate at a nonzero rate, thereby giving more realistic bounds than those derived from reversible processes. Some approaches tell us only the limits; others tell us also the process that would yield those limits. Frequently, they can infer how the lower bound on the energy they pay for operating at a nonzero rate depends on that rate of operation. There even exist processes for which no zero-rate reversible counterpart exists. The constraints attending operating in finite time reduce the limits on performance so much that it is desirable to find general methods to calculate more realistic limits that reflect those constraints.

4004 Electrochemistry

REFER ALSO TO CITATION(S) 24877, 25416

25414 **Low voltage solid-state lateral coloration electrochromic device.** Tracy, C.E.; Benson, D.K.; Ruth, M.R. (to Dept. of Energy, Washington, DC). US Patent 4,645,308. 24 Feb 1987. Filed date 21 Dec 1984. vp.

A solid-state transition metal oxide device is described comprising layers including cathode contact means, anode contact means, means including a layer of dielectric material and means including an electrochromic oxide layer. The means is arranged and oriented such that the application of a predetermined potential to the transition metal oxide device is effective for actuating blue coloration within the electrochromic oxide layer and wherein the coloration action sweeps across the length of the electrochromic oxide layer from the cathode contact means to the anode contact means.

25415 **Surface-enhanced Raman microspectroscopy at electrode surfaces.** Hembree D.M. Jr.; Oswald, J.C.; Smyrl, N.R. (Plant Laboratory, Product Certification Division, Oak Ridge Y-12 Plant, Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee 37831). *Applied Spectroscopy;* **41**: No. 2, 267-271(Feb 1987). Contract AC05-84OR21400.

Surface-enhanced Raman microspectroscopy has been developed as a technique for characterizing processes occurring at the electrode/electrolyte interface. A spectroelectrochemical cell was designed to obtain Raman spectra of electrochemical species with the use of microscope optics, which allowed unambiguous placement of laser focus at the electrode surface with spatial resolution on the order of 1 μm. It was also possible to visually inspect the surface morphology of the electrode with the use of the Raman microscope in the reflected-light mode. The capabilities of the spectroelectrochemical cell were demonstrated by observation of surface-enhanced Raman scattering (SERS) for a variety of model systems (pyridine, pyridinium ion, potassium cyanide) with the use of silver, copper, and nickel electrodes. The electrochemical behavior of a commercially important gold electroplating process is also reported.

4005 Photochemistry

REFER ALSO TO CITATION(S) 24700, 24724, 24725, 24726, 24877, 25411, 25412, 25423

25416 **(DOE/ER/13209—1) The study of photochemistry at semiconductor surfaces using total internal reflection techniques: Final report for period June 1, 1984-May 31, 1986.** Spitler, M.T. (Mount Holyoke Coll., South Hadley, MA (USA)). Jan 1987. Contract FG02-84ER13209. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87006259.

The photochemistry and photoelectrochemistry of organic dyes has been studied using internal reflection spectroscopy and standard photoelectrochemical techniques. The causes of the low efficiency for dye sensitized photocurrent at semiconductors have been established and systems found where sensitization is highly efficient. Internal reflection flash photolysis techniques have been perfected and demonstrated through the study of the photochemistry of the dye eosin adsorbed at semiconductor surfaces. The photochemical attachment of dyes to the electrode surface has also been demonstrated.

25417 **(DOE/ER/13633—1) Energy conversion processes based on molecular excited states: Progress report, August 1, 1986-July 31, 1987.** Meyer, T.J. (North Carolina Univ., Chapel Hill (USA)). Mar 1987. Contract FG05-86ER13633. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007408.

The major emphasis of our DOE-supported research efforts remains the use of molecular excited states in energy conversion processes. In the past year we have made significant progress in the distinct areas of: (1) electronic structure, photophysical and photochemical properties of MLCT-based excited states, (2) design and characterization of metallopolymeric films as a basis for photoelectrodes containing MLCT-based chromophores, and (3) excited state photoelectrochemical cells based on excited state redox quenching. We have continued to develop synthetic routes to new MLCT excited states, most recently to a series of complexes. Systematic variations (from electron-donating to electron-withdrawing properties) allow control to be gained over changes in emission energies (E/sub em/), excited state redox potentials, ground state absorption energies, and radiative and nonradiative decay rate constants and perhaps, most importantly, open up two new families of excited states for photoredox applications.

25418 **Resonance raman spectra of the ground and charge-transfer excited state of pentaammine(4,4′-bipyridine)ruthenium(II) and pentaammine(4,4′-bipyridinium)ruthenium(II).** Caswell, D.S.; Spiro, T.G. (Princeton Univ., NJ). *Inorganic Chemistry;* **26**: No. 1, 18-22(14 Jan 1987). Contract AC02-81ER10861.

Resonance Raman (RR) spectra are reported for aqueous Ru/sup II/$(NH_3)_5$(4,4′-bipyridine) (I) and Ru/sup II/$(NH_3)_5$(4,4′-bipyridine-H^+) (IH^+) in resonance with their charge-transfer absorptions (480 and 570 nm) using CW (Kr^+, 530.9 nm) and pulsed (YAG, 532 nm) laser excitation. Several RR bands are observed, which are assignable to symmetric and antisymmetric combinations of pyridine ring modes by comparison with the biphenyl vibrational spectrum. The previously reported RR spectra of Ru(2,2′-bipyridine)$_3{}^{2+}$ and of its charge-transfer excited state are also assigned in this framework. At high pulsed laser power levels new Raman bands grow in, which are attributed to ring modes in the charge-transfer excited states by analogy with the biphenyl radical anion RR spectrum. Even though the lifetimes of the charge-transfer states are known from transient absorption spectroscopy to be 36 and 230 ps for I and 30 ps for IH^+, the photon flux is estimated to be sufficient to produce a detectable steady-state population of excited molecules. The excited-state RR spectrum for I at pH 7 appears to contain overlapping contributions from protonated and unprotonated molecules. Although this behavior is not unexpected in view of the enhanced basicity anticipated for the uncoordinated pyridine N atom in the charge-transfer state, for which a pK/sub a/ of 11.4 is estimated, the short excited-state lifetimes imply that protonation must occur more rapidly than the equilibrium rate. 25 references, 4 figures, 1 table.

25419 **Studies of molecular adsorbates at interfaces by optical second-harmonic generation.** Tom, H.W.K.; Heinz, T.F.; Shen, Y.R. (Dept. of Physics, Univ. of California, Berkeley, CA 94720). pp 663-676 of Photochemistry and photobiology. Zewail, A.H. New York, NY; Harwood Academic Pub. (1983). (CONF-830128—).

From International conference on photochemistry and photobiology; Alexandria, Egypt (5 Jan 1983).

Optical second-harmonic generation (SHG) is surface-specific and has the sensitivity to detect submonolayers of molecules. It can be applied to study molecular adsorbates at the interface between any two centrosymmetric media. This has been demonstrated by using dye and rho-nitrobenzoic acid (PNBA) molecules adsorbed on smooth fused quartz substrates as examples. With resonant SHG, the S/sub 0/ → S/sub 2/ transition of the adsorbed dye molecules was measured. From the polarization dependence of the SHG, the orientation of PNBA at both the air/quartz and the ethanol/quartz interfaces was deduced. By varying the concentration of PNBA in ethanol, an adsorption isotherm for PNBA at the ethanol/quartz interfaces was also obtained.

4006 Radiation Chemistry

25420 **Time-domain EPR study of the SO^-a combination reaction: Radical pair CIDEP without singlet—triplet mixing.** Bartels, D.M.; Lawler, R.G. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Chemical Physics;* **86**: No. 9, 4843-4855(1 May 1987). Contract W-31-109-ENG-38;AC02-82ER12042.

The radical ion $xSO^-{}_3$ was studied by in situ pulsed radiolysis of aqueous alkaline sodium sulfite solutions in a pulsed EPR spectrometer. Initial radical concentrations on the order of 5 x 10^{-4} M were generated, and detailed measurements of the decay of $xSO^-{}_3$ magnetization were performed on the microsecond time scale. It was found that the second order decay of both longitudinal and transverse magnetization lags behind the second order decay of radical population when the reaction rate approaches the relaxation rates 1/T/sub 1,2/. The observations may be explained in terms of the spin-pairing requirements for formation of a singlet reaction product. The spin pairing gives rise to a "passive" form of radical pair mechanism (RPM) chemically induced dynamic electron polarization (CIDEP) which has previously gone unrecognized. RPM polarization therefore occurs in $xSO^-{}_3$ encounters despite the lack of hyperfine dependent singlet—triplet mixing between radical reencounters, which is necessary for the accepted RPM mechanism. The implications of these observations for the interpretation of time-resolved EPR experiments are discussed.

25421 **ESR and ENDOR study of the guanine cation: Secondary product in 5′-dGMP.** Hole, E.O.; Nelson, W.H.; Close, D.M.; Sagstuen, E. (Department of Physics and Astronomy, Georgia State University, Atlanta, Georgia 30303). *Journal of Chemical Physics;* **86**: No. 9, 5218-5219(1 May 1987).

Previous ESR studies of x-irradiated single crystals of 2′-deoxyguanosine-5′-monophosphate have indicated the presence of a radical thought to be formed by deprotonation of a primary base cation at N1. In this communication are reported some results of detailed ESR and ENDOR experiments at 10 K conflicting with the above results. One of the radicals detected exhibited two α-proton type couplings. The data analysis shows that one coupling is due to the exchangeable proton of the extra-annular NH_2 group, while the other is due to the proton bonded at C8. The experimental spin densities were rho(N10) = 0.33, and rho(C8) = 0.18. The results agree reasonably well with the INDO calculated spin density distribution of a radical formed by deprotonation at N10 of a primary cation radical. The radical is stable on warming to about 200 K where it anneals rapidly.

4007 Radiochemistry And Nuclear Chemistry

REFER ALSO TO CITATION(S) 25874, 25904, 25913, 25956

25422 **(PB—87-142154/XAB) Boron-isotope geochemistry. Doctoral thesis.** Spivack, A.J. (Woods Hole Oceanographic Institution, MA (USA)). 1986. 199p. (WHOI—86-10). NTIS, PC A09/MF A01.

An investigation of the major aspects of the boron-isotope geochemical cycle was carried out. Particular emphasis was directed at developing a reproducible, high-precision method for the determination of boron isotope ratios in geologic materials and determining the processes that influence the boron-isotope composition of seawater. A method for the determination of the isotopic composition of boron by thermal ionization mass spectrometry of $Cs_2B_4O_7$ is described. Samples analyzed for boron content and isotopic composition included: seawater, unaltered mid-ocean ridge basalts (MORB), altered MORB (dredge and core samples), serpentinized periodotites, marine sediments, marine sedimentary pore waters, hydrothermally altered sediments, oceanic hydrothermal solutions, rainwater, river water and suspended sediments, island arc volcanics and a soil profile.

25423 **Laser photodissociation of PuF_6 and transient product absorption in the visible.** Kim, K.C.; Campbell, G.M. (Los Alamos National Lab., NM). *Chemical Physics Letters;* **110**: No. 4, 417-419(5 Oct 1984).

PuF_6 molecules were flash-photolyzed in a static cell at 248 nm using a KrF excimer laser. The absorption by the transient product was detected in the wavelength region of 500-850 nm by probing the photolysis volume coaxially with a cw source. A measurement of the product absorption cross section at 632.8 nm is shown. The product absorption decay is discussed in terms of primary photolytic reactions among the product species. 7 references, 2 figures.

25424 **Recoil ^{18}F chemistry. XIII. High-pressure investigation of CF_4.** Knickelbein, M.B.; Knierim, K.D.; Root, J.W. (Univ. of California, Davis). *Chemical Physics (Amsterdam);* **83**: 235-245(1984). Contract AA03-76SF00034;AT03-76ER70158.

The reactions of nuclear recoil ^{18}F atoms with CF_4 have been studied in the gas phase. The principal hot reaction, F-for-F substitution, produces energy rich $CF_3{}^{18}F$ molecules that may undergo one or more sequential C-F bond dissociations. The unstable products $CF_2{}^{18}F$, $CF^{18}F$ and $C^{18}F$ react with Cl_2 to form $CF_2{}^{18}FCl$, $CF^{18}FCl_2$ and $C^{18}FCl_3$. The yields of the labeled organic species are measured using radio-gas-chromatography, and used to determine the reaction mechanism throughout the pressure range 0.5-91.4 kTorr. 39 references, 5 figures, 5 tables.

4008 Combustion, Pyrolysis, And High-temperature Chemistry

REFER ALSO TO CITATION(S) 24484, 24560, 24595, 24893, 25401, 25402

25425 **(LA-UR—86-4043) On the use of adaptive moving grid methods in combustion problems.** Hyman, J.M.; Larrouturou, B. (Los Alamos National Lab., NM (USA); Institut National de Recherche en Informatique et en Automatique (INRIA), 6 - Valbonne (France)). 1986. Contract W-7405-ENG-36. 14p. (CONF-8610217—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003715.

From 2. workshop on modelling of chemical reaction systems; Heidelberg, F.R. Germany (1 Oct 1986).

The investigators have presented the reasons and advantages of adaptively moving the mesh points for the solution of time-dependent PDEs (partial differential equations) systems developing sharp gradients, and more specifically for combustion problems. Several available adaptive dynamic rezone methods have been briefly reviewed, and the effectiveness of these algorithms for combustion problems has been illustrated by the numerical solution of a simple flame propagation problem. 29 refs., 7 figs.

25426 **(N—87-11960) Simulations of turbulent mixing and reacting flows and their applications to turbulence modeling. Semiannual progress report.** Ferziger, J.H.; Cantwell, B.J. (Stanford Univ., CA (USA)). Jul 1986. 21p. (NASA-CR—179829; NAS—1.26:179829). NTIS, PC A02/MF A01.

The method of full simulation is applied to reacting turbulent flows. Full simulation has proven of great value as a complement to experiments for the study of nonreacting turbulent flows. It provides insight into the physics of turbulent flows and their modeling. It is natural to try to extend these methods to the simulation of reacting turbulent flows. Because this is one of the first attempts at this type of simulation, a subsidiary goal of this work is to demonstrate the feasibility of using simulation to study turbulent reacting flows. In addition, it is shown that such simulations can be used to provide physical insight into the nature of turbulent combustion and to provide data that will help to construct models that can be used in engineering simulations of turbulent reacting flows.

25427 **(SAND—87-8213) Sandia cooperative group on the aerothermochemistry of turbulent combustion.** Dibble, R.W.; Carling, R.W.; Johnston, S.C. (Sandia National Labs., Livermore, CA (USA)). Mar 1987. Contract AC04-76DR00789. 54p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87008345.

A turbulent reacting flow working group has been established through the Department of Energy/Office of Basic Energy Sciences. The purpose of this group is to establish and maintain a strong interaction and active dialogue between workers currently involved in modeling turbulent reacting flows and those involved in related experiments. One objective of this collaboration is to develop an increased understanding of the fundamental interaction between the chemical and fluid dynamical processes occurring in chemically reacting flows and to utilize this understanding to improve predictive capabilities for turbulent combustion. Regular members, who represent academia, private industry, and national laboratories, and guests participate in the meetings. Several guests are invited to each meeting to provide an influx of different ideas and opinions to the discussions. This document is a summary of the discussions that took place during the seventh and eighth meetings, which were held at California Institute of Technology, Pasadena, CA, March 25-26, 1986 and Yale University, New Haven, CT, October 13-14, 1986, respectively.

42 ENGINEERING

25428 **(ESA-ESTL—7) Activities report in space tribology. Progress report, 1985.** Todd, M.J. (European Space Tribology Lab., Risley (UK)). Jan 1986. 17p. (ESA-CR(P)—2236; ETN—86-98114). NTIS, PC A02/MF A01.

The improvement in MoS_2 sputtered films, the elucidation of atmosphere effects on composite brushes and on MoS_2 films, and a method for Coulomb torque hysteresis prediction are described. Tests on the Giotto despin mechanism are outlined. Cryogenic tribology, solid lubricant films, gear tribology, and numerical analysis are discussed.

25429 **(N—87-16742) Research reports: 1986 NASA/ASEE summer faculty fellowship program.** Freeman, L.M.; Speer, F.A.; Cothran, E.K.; Karr, G.R. (National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center). Nov 1986. 1022p. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—). NTIS, PC A99/MF E04.

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

For the 22th consecutive year, a NASA/ASEE Summer Faculty Fellowship Program was conducted for the summer of 1986 by the University of Alabama and Marshall Space Flight Center. The basic objectives of the program are: (1) to further the professional knowledge of qualified engineering and science faculty members; (2) to stimulate an exchange of ideas between participants and NASA; (3) to enrich and refresh the research and teaching activities of the participants' institution; and (4) to contribute to the research objectives of the NASA center. The Faculty Fellows spent ten weeks at MSFC engaged in a research project compatible with their interest and background and worked in collaboration with a NASA/MSFC colleague. This is a compilation of Fellows' reports on their research.

25430 **(NP—7751724) Technical University of Hamburg-Harburg. Research report 1980-1983.** (Technische Univ. Hamburg-Harburg (Germany, F.R.)). Nov 1983. 142p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE87751724.

The newly established Technical University of Hamburg-Harburg presents its first research report comprising the period from January 1980 to July 1983. It contains contributions from the 6 focal points of research: manufacturing and production engineering, materials research, safety engineering, marine techniques, building construction and engineering, and municipal reconstruction and renovation engineering.

25431 **(SAND—86-2564) CADCAM-005: An introduction to the data exchange process using IGES.** Kelly, J.C.; Parks, R.E.; Saylors, D.B. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008079.

This introductory report deals with some of the ingredients of the data exchange process. Current vendor interactive graphics CAD/CAM systems (Applicon, Calma, Computervision, CD-2000, ANVIL-4000, etc.) are discussed from a generic point of view. Also discussed is the data format given in the Initial Graphics Exchange Specification, which is intended to be a standardized format for the communication of data between interactive graphics CAD/CAM systems. 12 refs., 7 figs.

4202 Facilities And Equipment

REFER ALSO TO CITATION(S) 24416, 24520, 24668, 25099, 25197, 25362, 25363, 25372, 25757

25432 (AD-A—176307/7/XAB) Review of biomedical aspects of CB masks and their relationship to military performance. Technical report. Muza, S.R. (Army Research Inst. of Environmental Medicine, Natick, MA (USA)). Nov 1986. 46p. NTIS, PC A03/MF A01.

This review describes the most important factors affecting military work performance while wearing a CB mask: (1) the additional inspiratory and expiratory breathing resistance; (2) increased external dead space; (3) thermal stress of the mask and hood; (4) restriction of functional vision; (5) hindrance of speech transmission and reception; (6) weight, size, and pressure on the face by the CB mask; (7) claustrophobic reactions, and (8) sleep loss and lack of nutrient intake due to long-term wear. In assessing the biomedical aspects of these factors, rather than making comparisons between specific models of CB masks, the review addresses these factors as they apply to CB masks in general.

25433 (CONF-870354—1) 3-D world modeling based on combinatorial geometry for autonomous robot navigation. Goldstein, M.; Pin, F.G.; de Saussure, G.; Weisbin, C.R. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 21p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87002814.

From IEEE international conference on robotics and automation; Raleigh, NC, USA (30 Mar 1987).

In applications of robotics to surveillance and mapping at nuclear facilities, the scene to be described is fundamentally three-dimensional. Usually, only partial information concerning the 3-D environment is known a-priori. Using an autonomous robot, this information may be updated using range data to provide an accurate model of the environment. Range data quantify the distances from the sensor focal plane to the object surface. In other words, the 3-D coordinates of discrete points on the object surface are known. The approach proposed herein for 3-D world modeling is based on the Combinatorial Geometry (C.G.) Method which is widely used in Monte Carlo particle transport calculations. First, each measured point on the object surface is surrounded by a small solid sphere with a radius determined by the range to that point. Then, the 3-D shapes of the visible surfaces are obtained by taking the (Boolean) union of all the spheres. The result is a concise and unambiguous representation of the object's boundary surfaces. The distances from discrete points on the robot's boundary surface to various objects are calculated effectively using the C.G. type of representation. This feature is particularly useful for navigation purposes. The efficiency of the proposed approach is illustrated by a simulation of a spherical robot navigating in a 3-D room with several static obstacles.

25434 (DOE/CE/15207—T6) Energy saving pump and pumping system: Final report. Chang, Kai-Chih. (Innovative Technology Labs., Richland, WA (USA)). 23 Mar 1987. Contract FG01-85CE15207. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007739.

Five laboratory prototype pumps, in accordance with the Cool Pump working principle, have been built and successfully tested. This pump can run safely at shut-off. A test has been performed with running a prototype pump continuously with shut-off discharge for over three days. No heat build-up in the pump casing or any other problems was detected. Of the prototype pumps, three are designed with dimensions compatible with standard conventional centrifugal pumps so that they can be constructed with standard components such as motors, bearings and seals, and also it can replace a conventional pump without changing installation spacing. This design also assures that the manufacturing cost of this new pump should be very comparable with conventional pumps. The developmental effort shows that the Cool Pump is technically feasible and cost effective. The efficiencies of the prototypes are equal to or better than the conventional centrifugal pumps of the same capacities. The advantages include 10% to 30% energy saving, inherent protection from low flow overheating, improvement in system and operational simplicity and reliability and longer seal life.

25435 (DOE/ER/13205—3) Method of vibrational control in the problem of stabilization of chemical reactors: Dynamical systems with fast parametric oscillations: Final report for period of March 1, 1984-November 30, 1986. Cinar, A. (Illinois Inst. of Tech., Chicago (USA). Dept. of Chemical Engineering). Feb 1987. Contract FG02-84ER13205. 59p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006411.

The objective of this project was the stabilization of chemical reactor operation in the unstable steady state region by vibrational control and productivity improvement with respect to stationary operation of the reactor system. Experimental validation of asymptotically stable periodic operation of chemical reactors in the vicinity of an unstable equilibrium point was carried out for the first time in this project, using high frequency and high amplitude vibrations in the reactor input variables. Theoretical and experimental studies were conducted using multiple vibrating inputs and the effect of phase shift between vibrating inputs was investigated. With multiple oscillating inputs, the amplitude of reactor temperature oscillations was greatly reduced and conversions higher than the conversions corresponding to the average reactor temperature were obtained. Two packed-bed reactor systems have been constructed for studying the benefits of vibrational control in catalytic reactor systems. A packed-bed CSTR with a Berty reactor was constructed for selectivity and yield improvement studies in ethylene oxidation. A tubular CO oxidation reactor system was developed for investigating vibrational control of distributed parameter systems. For the CO oxidation reactor system, bifurcation diagrams were developed, stable operating regions were determined and preliminary simulation studies on conversion improvements by vibrational operation of the reactor were initiated.

25436 (N—87-11965) Losses in fountain-effect pumps. Kittel, P. (National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center). Apr 1986. 9p. (NASA-TM—88232; A—86184; NAS—1.15:88232). NTIS, PC A02/MF A01.

Three loss mechanisms in fountain-effect pumps are identified and analyzed. Two of these mechanisms reduce the mechanocaloric effect, by reducing the mass transferred per unit heat input. The first loss mechanism of these losses is the result of normal fluid leakage through the pump. The second loss mechanism is the result of the finite separation between the porous plug and the heater. The third loss mechanism reduces the thermomechanical effect. It results from the Gorter-Mellink interaction within the porous plug. All three of these loss mechanisms are shown to reduce pump efficiency. They are then applied to an example to illustrate the relative significance of the three mechanisms.

25437 (N—87-12018) User manual for BUNVIS-RG: an exact buckling and vibration program for lattice structures, with repetitive geometry and substructuring options. Anderson, M.S.; Williams, F.W.; Banerjee, J.R.; Durling, B.J.; Herstrom, C.L.; Kennedy, D.; Warnaar, D.B. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Nov 1986. 50p. (NASA-TM—87669; NAS—1.15:87669). NTIS, PC A03/MF A01.

A computer program is described which is especially suited for making vibration and buckling calculations for prestressed lattice structures that might be used for space application. Structures having repetitive geometry are treated in a very efficient manner. Detailed instructions for data input are given along with several example problems illustrating the use and capability of the program.

25438 (N—87-15442) Evaluation of seals for high-performance cryogenic turbomachines. Hendricks, R. C.; Tam, L. T.; Braun, M. J.; Vlcek, B. L. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1987. 15p. (NASA-TM—88919; E—3348; NAS—1.15:88919; CONF-870854—1). NTIS, PC A02/MF A01.

From 17. international congress of refrigeration; Vienna, Austria (24 Aug 1987).

An approach to computing flow and dynamic characteristics for seals or bearings is discussed. The local average velocity was strongly influenced by inlet and exit effects and fluid injection, which in turn drove zones of secondary flow. For the restricted three-dimensional model considered, the integral averaged results were in reasonable agreement with selected data. Unidirectional pressure measurements alone were insufficient to define such flow variations. However, for seal and bearing leakage correlations the principles of corresponding states were found to be useful. Also discussed are three phenomena encountered during testing of three eccentric nonrotating seal configurations for the Space Shuttle Main Engine (SSME) Program. Fluid injection, choking within a seal, and pressure profile crossover are related to postulated zones of secondary flow or separation and to direct stiffness.

25439 (N—87-16014) **NASA/DOD control/structures interaction technology, 1986.** Wright, R. L. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Nov 1986. 549p. (NASA-CP—2447-PT-1; L—16242-PT-1; NAS—1.55:2447-PT-1; CONF-8611149—). NTIS, PC A23/MF A01.

From NASA/DOD control/structures interaction technology conference; Norfolk, VA, USA (18 Nov 1986).

Control/structures interactions, deployment dynamics and system performance of large flexible spacecraft are discussed. Spacecraft active controls, deployable truss structures, deployable antennas, solar power systems for space stations, pointing control systems for space station gimballed payloads, computer-aided design for large space structures, and passive damping for flexible structures are among the topics covered.

25440 (N—87-16321) **20th Aerospace Mechanics Symposium.** (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). May 1986. 316p. (NASA-CP—2423-REV; E—2904; NAS—1.55:2423-REV; CONF-860560—). NTIS, PC A14/MF A01.

From 20. aerospace mechanism symposium; Cleveland, OH, USA (7 May 1986).

Numerous topics related to aerospace mechanisms were discussed. Deployable structures, electromagnetic devices, tribology, hydraulic actuators, positioning mechanisms, electric motors, communication satellite instruments, redundancy, lubricants, bearings, space stations, rotating joints, and teleoperators are among the topics covered.

25441 (N—87-16321, pp vp) **Towards an optimised sputtered MoS_2 lubricant film.** Roberts, E. W. May 1986. NTIS, PC A14/MF A01. (NASA-CP—2423-REV; E—2904; NAS—1.55:2423-REV; CONF-860560—).

From 20. aerospace mechanism symposium; Cleveland, OH, USA (7 May 1986).

It is shown that the tribological quality of MoS_2 lubricant films formed by magnetron sputtering is determined by the choice of sputtering conditions. By selecting the appropriate conditions, films of extremely high lubricity and endurance (in vacuum), which are well suited to many space applications, are obtained. Such MoS_2 films, when applied to precision ball hearings, give rise to the lowest torques (for the given test conditions) yet seen in our laboratory. While a remarkably good performance is obtained in vacuum, tests in air show a marked deterioration in lubricating qualities. It is demonstrated that this is attributable to the adsorption of water vapor on MoS_2 surfaces and that the degree of deterioration is related to the partial pressure of water vapor present. Analysis of results indicates that the factors relevant to obtaining optimum films are deposition rate and film composition.

25442 (N—87-16742, pp vp) **Study of boiling heat transfer as applied to the cooling of ball bearings in the high pressure oxygen turbopump of the space shuttle main engine.** Schreiber, W. Nov 1986. NTIS, PC A99/MF E04. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—).

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

Two sets of ball bearings support the main shaft within the High Pressure Oxygen Turbopump (HPOTP) in the Space Shuttle Main Engine (SSME). In operation, these bearings are cooled and lubricated with high pressure liquid oxygen (LOX) flowing axially through the bearing assembly. Currently, modifications in the assembly design are being contemplated in order to enhance the lifetime of the bearings and to allow the HPOTP to operate under larger loads. An understanding of the fluid dynamics and heat transfer characteristics of the flowing LOX is necessary for the implementation of these design changes. The proposed computational model of the LOX fluid dynamics, in addition to dealing with a turbulent flow in a complex geometry, must address the complication associated with boiling and two-phase flow. The feasibility of and possible methods for modeling boiling heat transfer are considered. The theory of boiling as pertains to this particular problem is reviewed. Recommendations are given for experiments which would be necessary to establish validity for correlations needed to model boiling.

25443 (PB—87-143012/XAB) **Francis Bitter National Magnet Laboratory. Annual Report, July 1985-June 1986.** (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). 1986. 162p. NTIS, PC A08/MF A01.

Contents include: reports on laboratory research programs--(quantum optics, magnetism, condensed matter chemistry, superconductivity, magnetic separation, magnetic fields of the brain, molecular biophysics, solid-state nuclear magnetic resonance, magnet technology, instrumentation for high-magnetic-field research); reports of visiting scientists-- (reports of users of the high-magnetic-field facility, reports of users of the pulsed-field facility, reports of users of the squid magnetometer and Moessbauer facility); appendices: (publications and meeting speeches, organization, summary of high-field magnet facility use January 1, 1981 through December 31, 1985, July 1, 1985 through June 30, 1986, geographic distribution of high-field magnet users (excluding laboratory staff), summary of educational activities); author index.

25444 (REG/G—3.1-Rev.2) **Use of borosilicate-glass raschig rings as a neutron absorber in solutions of fissile material: Proposed Revision 2 to Regulatory Guide 3.1.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Mar 1987. 7p. Nuclear Regulatory Commission Washington, DC 20555. File Number TI87900577.

Section 70.22, "Contents of Applications," of 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," requires that applications for a specific license to own, acquire, deliver, receive, possess, use, or transfer special nuclear material contain proposed procedures to avoid accidental conditions of criticality. Procedures for this purpose include incorporating neutron-absorbing material such as boron in process equipment. This regulatory guide provides guidance for complying with this portion of the Commission's regulations by describing procedures acceptable to the NRC staff for the prevention of criticality accidents by use of borosilicate-glass raschig rings as a neutron absorber in solutions of fissile material.

25445 (SAND—87-0336C) **Forced vibration as a method for determining structural integrity.** Rogers, J.D. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 4p. (CONF-870482—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005878.

From 14. Department of Energy compatibility, aging and service life conference; Amarillo, TX, USA (28 Apr 1987).

This work presents a method for determining material damping from forced vibration tests by measuring the driving force required at resonance. The force measurement is broken into its various frequency components which allowed the investigation of the harmonic frequency generation associated with specific flaws. (LEW)

25446 **Radial pressure flange seal.** Batzer, T.H.; Call, W.R. (to Dept. of Energy). US Patent Application 6-895,643. 12 Aug 1986. 15p. Contract W-7405-ENG-48. DE87007208 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007208.

This invention provides an all metal seal for vacuum or pressure vessels or systems. This invention does not use gaskets. The invention uses a flange which fits into a matching groove. Fluid pressure is applied in a chamber in the flange causing at least one of the flange walls to radially press against a side of the groove creating the seal between the flange wall and the groove side.

25447 Incomplete state feedback for time delay systems: observer applications in multidelay compensation. Ogunnaike, B.A.; Ray, W.H. (Univ. of Wisconsin, Madison). *A.I.Ch.E. Journal (New York);* **30**: No. 5, 717-724(Sep 1984). Contract AC02-80ER10645.

This paper demonstrates how a recently developed observer for time delay systems may be used to estimate needed state variables for implementation of multivariable time delay compensation. The general results are illustrated by an example of a multireactor plant in which only one reactor concentration can be measured. The observer worked well in simulation for both multivariable PID control and multidelay compensated PID control and allowed both schemes to function with estimated state variables in the feedback loop. 16 references, 5 figures.

4203 Lasers

REFER ALSO TO CITATION(S) 24711, 25266, 25267, 25268, 26317

25448 (AD-A—175205/4/XAB) Chemical Laser Phase Conjugation Technology (CLPCT). Final report, 10 July 1985-9 November 1986. Schnurr, A.D.; Meisenholder, S.; Quon, S.; Betts, J.; Doyle, J. (TRW, Inc., Redondo Beach, CA (USA). Applied Technology Div.). 30 Nov 1986. 126p. (TRW-AP—0923). NTIS, PC A07/MF A01.

The final report for the Chemical Laser Phase Conjugation Technology (CLPCT) project presents the detailed design for an experimental facility for use in future phase-conjugation experiments, which will be conducted under a separate project. The objective of the CLPCT program was to design a facility that (1) is compatible with the use of an existing 50-liter repetitively HF pulsed chemical laser (RPCL) device and (2) would allow design flexibility/growth potential for other more-complex experiments. The detailed design of the facility for the HF Conjugation experiment is described. Phase conjugation is developed by the nonlinear optical process wherein the high energy HF chemical laser beam is focused within a stimulated Brillioun scattering (SBS) cell which is filled with xenon at 40 atmospheres. The experimental facility consists of the oscillator subsystem, RPCL subsystem, diagnostics subsystem and phase-conjugation subsystem. The detailed design of each subsystem is described. In addition, the conceptual is described. A flowing SBS cell was developed for this experiment.

25449 (AD-A—175421/7/XAB) Studies of elementary processes and coupling involved in the D_2/F_2 chemical laser. Final report, 1 October 1984-31 December 1985. Tardy, D.C. (Iowa Univ., Iowa City (USA). Dept. of Chemistry). 1 Dec 1986. 110p. (UI-CHEM-DCT—86). NTIS, PC A06/MF A01.

The performance of a H_2/D_2 chemical laser is a function of the nascent-energy-disposal parameters for the F + H_2 (D_2) and H (D) + F_2 chemical reactions and the vibrational relaxation of HF (DF). Chemiluminescence Mapping (CM) in which chemical components are observed by their spectral and time resolution is a technique which is capable of providing fundamental information on both nascent energy distributions for bimolecular exchange reactions and vibrational relaxation. Knowledge of the reactants (atoms or ions) and residence times must be known in order to interpret the data. Using a double floating probe the ion content flowing from a microwave discharge of hydrogen was found to be <.0000018 of the total flow, thus ion molecule reactions are unimportant. The interpretation of CM experiments requires realistic modeling to deconvolute the experimental data. Both types of CM experiments provide nascent vibrational energy distributions. CM-LP experiments also provide total reaction rate constants and microscopic relaxation rate constants. In addition to the F + H_2(D_2) benchmark reactions, experimental results for H(D) + F_2, F + HBr, and F + CH_2C_{12} are discussed and compared to other studies when available.

25450 (AD-A—176057/8/XAB) Observations of gain compression in a GaAlAs diode laser through a picosecond transmission measurement. Johnson, B.C.; Mooradian, A. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 3 Nov 1986. 4p. (JA—5859). NTIS, PC A02/MF A01.

Published in Applied Physics Letters, Vol. 49, No. 18, 1135-1137(3 Nov 1985).

The carrier density and light output of a pulse-modulated GaAlAs diode laser were measured with picosecond time resolution. A new technique for measuring carrier density by transmission of picosecond light pulses through a diode laser is described. The measured carrier density was compared with a density calculated from the light output data using a rate-equation analysis. Gain compression of a magnitude expected from relaxation oscillation damping rates was observed. Because the experiment measures the density at the center of the waveguide, and not the average across the active layer, the compression mechanism is not spatial hole burning.

25451 (AD-A—176301/0/XAB) Investigation of plasma processes in electronic-transition lasers. Annual report, 1 January-31 December 1986. Nighan, W.L. (United Technologies Research Center, East Hartford, CT (USA)). 15 Dec 1986. 65p. (UTRC/R—86-927162-1). NTIS, PC A04/MF A01.

An investigation is conducted of the fundamental processes affecting the operation, performance, and application of electrically excited lasers having potential utility in a variety of areas of importance to the Navy. Particular attention is presently focused on the broadband XeF(C to A) laser, which has the potential for efficient, tunable operation throughout the blue green spectral region.

25452 (LA—10884-MS) Development of a high temperature ceramic-to-metal seal for Air Force Weapons Laboratory Laser. Honnell, R.E.; Stoddard, S.D. (Los Alamos National Lab., NM (USA)). Mar 1987. Contract W-7405-ENG-36. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007711.

Procedures were developed for fabricating vacuum tight metal-to-ceramic ring seals between Inconel 625 and MgO-3 wt % Y_2O_3 tubes metallized with a calcia-alumina-silica glass (CaO-29 wt % Al_2O_3-35 wt % SiO_2) containing 50 vol % molybdenum filler. Palniro No. 1 (Au-25 wt % Pd-25 wt % Ni) was found to be the most reliable braze for joining Inconel to metallized MgO-3 wt % Y_2O_3 bodies. The reliabilities of the processing procedures and the material systems were demonstrated. A prototype electrical feedthrough was fabricated for 1173°K operation in air or vacuum.

25453 (UCRL—15712) Long lifetime silicate laser glass compositions. Mueller, H.; Perle, L.M. (Schott Glass Technologies, Inc., Duryea, PA (USA); Lawrence Livermore National Lab., CA (USA)). Aug 1985. Contract W-7405-ENG-48. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008164.

This contract had as target the development of a silicate laser glass with the following properties: (1) fluorescence lifetime greater than LG-660, (2) induced emission cross-section greater than 1.5×10^{-20} cm^2, and (3) tank meltability. In order to obtain such a glass, the compositional space between LG-660 and LG-650 was to be investigated. The Nd^{3+} concentration for a megajoule laser glass will be between 5 and 8×10^{20} ions/cm^3. Since concentration quenching is most severe at higher concentrations, we elected to test all glasses with a concentration of approximately 8×10^{20} Nd^{3+} ions/cm^3, with the exception of glass which is to be used to test tank meltability (refractory wear). In these glasses all Nd_2O_3 was replaced by La_2O_3. Besides investigating the compositional space between LG-660 and LG-650, a few excursions were made testing some existing optical glasses for their suitability as a laser glass (melts LLS-4, 5, and 6).

25454 (UCRL—15867-Vol.2) New laser materials: Final report. (Allied Corp., Morristown, NJ (USA); Lawrence Livermore National Lab., CA (USA)). Oct 1986. Contract W-7405-ENG-48. 57p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006723.

In the Interim Report No. 1, it was reported that the fluorescence lifetime (≧ 750μs) in Nd doped $Y(PO_3)_3$ was longer by a factor of three as compared to YAG. This means potentially three times as much energy storage and consequently more efficient for flashlamp pumping. It also makes diode pumping easier. In addition, since the Y site is octahedrally coordinated, there is a possibility of energy transfer using Cr as the sensitizing element. As suggested by W. Krupke, we decided to explore the trivalent cation metaphosphates systematically. The compounds investigated can be represented by the general formula $A(PO_3)_3$ where A = Y, Lu, In, Sc, GA and Al. The object is to study the fluorescence characteristics of Nd and Cr as well as the effectiveness of energy transfer from Cr to Nd. In addition, we also investigated other possible laser host crystals, notably $CaMgSi_2O_6$ (diopside), $LaBO_3$ and $La(BO_2)_3$. Results on these materials will also be discussed.

25455 **(UCRL—15878) Large GSGG [gadolinium scandium gallium garnet] crystal growth development: Final report, 1 October 1985-30 November 1986.** (Allied-Signal Corp., Charlotte, NC (USA). Synthetic Crystal Products; Lawrence Livermore National Lab., CA (USA)). Dec 1986. Contract W-7405-ENG-48. 71p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87008165.

The primary objective was to scale up the growth of chromium and neodymium doped gadolinium scandium gallium garnet (Cr:Nd:GSGG) crystals to 5.1 inches (13 cm) diameter by 8 inches (20 cm) in length. From such a crystal could be fabricated as many as five laser slabs 1 x 10 x 20 cm.

25456 **(UCRL—15879) Technical report of biota, FEL Site 1, Lawrence Livermore National Laboratory: Final report.** Taylor, D.W.; Davilla, W.; Orloff, S. (BioSystems Analysis, Inc., Sausalito, CA (USA); Lawrence Livermore National Lab., CA (USA)). 26 Sep 1986. Contract W-7405-ENG-48. 93p. NTIS MF A01; 2; GPO Dep. File Number DE87006724.

Lawrence Livermore National Laboratory is considering an expansion of laser test facilities adjacent to its existing LLNL Site 300 test location. Construction of a free-electron laser, known as the FEL Project, is being considered on approximately 3900 hectates (10,500 acres) of land. We will refer to this proposed site as FEL Site 1. Knowledge of the flora and vegetation resources of the proposed FEL Site 1 is necessary in order to plan for construction, operation, and possible future expansion of the FEL facility. The purpose of botanical sections of this report is to quantitatively describe the variation of vegetation on FEL Site 1, and to relate the vegetation to potential environmental impacts associated with present operation and possible expansion of site facilities. The primary purpose of the wildlife studies was to determine the presence and status of any endangered, threatened, fully protected, or otherwise sensitive species on FEL Site 1 that might be affected by the proposed FEL project. We directed our studies mainly toward the federally endangered San Joaquin kit fox (Vulpes macrotis mutica), but also toward another 14 special status species that potentially occur on site, including the state threatened Alameda striped racer (Masticophis lateralis euryxanthus).

25457 **(UCRL—15891) GSGG edge cladding development: Final technical report.** Izumitani, T.; Meissner, H.E.; Toratani, H. (Hoya Optics, Inc., Fremont, CA (USA); Lawrence Livermore National Lab., CA (USA)). 15 Nov 1986. Contract W-7405-ENG-48. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008163.

The objectives of this project have been: (1) Investigate the possibility of chemical etching of GSGG crystal slabs to obtain increased strength. (2) Design and construct a simplified mold assembly for casting cladding glass to the edges of crystal slabs of different dimensions. (3) Conduct casting experiments to evaluate the redesigned mold assembly and to determine stresses as function of thermal expansion coefficient of cladding glass. (4) Clad larger sizes of GGG slabs as they become available. These tasks have been achieved. Chemical etching of GSGG slabs does not appear possible with any other acid than H_3PO_4 at temperatures above 300°C. A mold assembly has been constructed which allowed casting cladding glass around the edges of the largest GGG slabs available (10 x 20 x 160 mm) without causing breakage through the annealing step.

25458 **Visible, room-temperature, surface-emitting laser using an epitaxial Fabry—Perot resonator with AlGaAs/AlAs quarter-wave high reflectors and AlGaAs/GaAs multiple quantum wells.** Gourley, P.L.; Drummond, T.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Physics Letters;* **50**: No. 18, 1225-1227(4 May 1987). Contract AC04-76DP00789.

We report operation of a new surface-emitting laser. This epitaxial laser is fabricated with molecular beam epitaxy by the growth of quarter-wave high reflectors of AlAs/Al/sub 0.4/Ga/sub 0.6/As (710 A/630 A) which surround a 4.5-μm-thick multiple quantum well of GaAs/Al/sub 0.4/Ga/sub 0.6/As (100 A/200 A). We characterize the structure with cw spectroscopy (absorption, reflection, and luminescence) and investigate stimulated emission spectra under pulsed photopumping. When photopumped, the structure lases in its as-grown condition without need of substrate removal, cleaving, or heatsinking. The lasing wavelength is as short as 7400 A and can be tuned to as long as 8400 A by positioning the pump spot to different regions across the wafer. The pulsed threshold irradiance has a very weak temperature dependence varying from 6×10^5 W/cm^2 at 4.2 K to 1.6×10^6 W/cm^2 at 295 K.

25459 **Torsional dynamics of molecules on barrierless potentials in liquids. I. Temperature and wavelength dependent picosecond studies of triphenyl-methane dyes.** Ben-Amotz, D.; Harris, C.B. (Department of Chemistry, University of California at Berkeley, and Materials and Molecular Research Division of Lawrence Berkeley Laboratory, Berkeley, California 94720). *Journal of Chemical Physics;* **86**: No. 9, 4856-4870(1 May 1987). Contract AC03-76SF00098.

The nonradiative decay dynamics of crystal violet, and other triphenyl-methane dyes, dissolved in a variety of solvents, are studied as a function of temperature. A linear viscosity dependence of the excited state absorption decay time in n-alcohol solvents is found at several constant temperatures. The temperature dependence at constant viscosity is anomalously negative over the entire viscosity range (0.6 to 8.0 cP) of these experiments. Various possible mechanisms for the observed behavior are critically discussed. Two color excite-and-probe studies reveal ground state bleach recovery times which are independent of excitation wavelength but strongly dependent on probe wavelength. The faster decay on the red side of the ground state absorption is shown to be the result of stimulated emission rather than the influence of a second state.

25460 **Transitions in lithium like Cu/sup 26+/ and beryllium like Cu/sup 25+/ of interest for x-ray laser research.** Brown, C.M.; Ekberg, J.O.; Feldman, U.; Seely, J.F.; Richardson, M.C.; Marshall, F.J.; Behring, W.E. (E.O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375-5000). *Journal of the Optical Society of America B: Optical Physics;* **4**: No. 4, 533-538(Apr 1987).

Transitions in highly charged copper ions have been identified in the extreme-ultraviolet spectra from plasmas produced by the Omega laser at the University of Rochester. The 24 beams of the Omega laser were focused to separate spots of diameter 50 μm upon the surface of copper-coated targets 600 μm in diameter. The transitions in lithium like Cu/sup 26+/ and beryllium like Cu/sup 25+/ of the type n = 3—4 were observed in the wavelength region 24 to 28 A and were bright in the focal regions. The intensities of the Cu/sup 26+/ 2p—3d and 3d—4f transitions indicate that a population inversion occurs between the 3d and 4f levels. Comparisons of the observed relative intensities of the Cu/sup 26+/ transitions with calculated intensities indicate that the Cu/sup 26+/ spectrum originates in a plasma region with an electron density of order of 10^{20} cm^{-3} and that collisional recombination is important for populating the 4f level. The 3d—4f transitions at 25.525 and 25.636 A in Cu/sup 26+/, and the same transitions in neighboring elements, appear to be good candidates for achieving gain at wavelengths below the carbon absorption edge at 43.5 A.

25461 **X-ray laser research at the Lawrence Livermore National Laboratory Nova laser facility.** Matthews, D.; Rosen, M.; Brown, S.; Ceglio, N.; Eder, D.; Hawryluk, A.; Keane, C.; London, R.; MacGowen, B.; Maxon, S. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550). *Journal of the Optical Society of America B: Optical Physics;* 4: No. 4, 575-587(Apr 1987). Contract W-7405-ENG-48.

We describe our optical-laser-pumped x-ray laser program. Our long-term goal is to develop and utilize a fully coherent, gigowatt-power-level sub-44-A laser. To this end we have been studying the characteristics of the exploding-foil amplifier coupled with various inversion schemes: Ne-like and Ni-like collisional excitation as well as H-like three-body recombination. Most of our experimental results to date are for the Ne-like schemes; we have observed —15 laser transitions in Se, Y, and Mo having wavelengths from 26.3 to 10.6 nm. Output power to at least 1 MW has been observed for the Se $J = 2$ to 1 lines at 20.6 and 20.9 A along with geometrical divergence patterns for the beam. We have also observed time-dependent beam refraction from these amplifiers and have been able to demonstrate double-pass amplification by using a multilayer mirror operated at normal incidence. Future plans for improving beam coherence and producing lasing at wavelengths shorter than 44 A are discussed.

25462 **Studies of multiphoton production of vacuum-ultraviolet radiation in the rare gases.** McPherson, A.; Gibson, G.; Jara, H.; Johann, U.; Luk, T.S.; McIntyre, I.A.; Boyer, K.; Rhodes, C.K. (Department of Physics, University of Illinois at Chicago, P.O. Box 4348, Chicago, Illinois 60680). *Journal of the Optical Society of America B: Optical Physics;* 4: No. 4, 595-601(Apr 1987).

Measurements of the vacuum-ultraviolet (<80-nm) radiation produced by intense ultraviolet (248-nm) irradiation (10^{15}—10^{16} W/cm^2) of rare gases have revealed the copious presence of both harmonic radiation and fluorescence from excited levels. The highest harmonic observed was the seventeenth (14.6 nm) in Ne, the shortest wavelength ever produced by that means. Strong fluorescence was seen from ions of Ar, Kr, and Xe, with the shortest wavelengths observed being below 12 nm. Furthermore, radiation from inner-shell excited configurations in Xe, specifically the $4d^{10}5s5p \rightarrow 4d^{10}5s$ manifold of Xe^{7+} at —17.7 nm, was detected. These experimental findings, in alliance with other studies concerning multielectron processes, give evidence for a role of electron correlations in a direct nonlinear process of inner-shell excitation.

25463 **(AD-A—175493/6/XAB) Gain properties of free-electron lasers under the actions of gradient magnetic fields.** Zhao, D.; Lei, S.; Chen, J. (Air Force Systems Command, Wright-Patterson AFB, OH (USA). Foreign Technology Div.). 4 Dec 1986. Translation of Honghuan Yanjiu (China), Vol. 4, No. 6, 428-432(1985). (FTD-ID(RS)T—0984-86). 12p. NTIS, PC A02/MF A01.

Gain properties of free-electron lasers are calculated in which a gradient magnetic field is superposed on a spatially periodic magnetic field along the axis of the wiggler. It is shown that better operating properties of laser gain are obtained by the use of a gradient magnetic field than of a uniform magnetic field.

25464 **High-power 35 GHz testing of a free-electron laser and two-beam accelerator structures.** Hopkins, D.B.; Kuenning, R.W.; Selph, F.B.; Sessler, A.M.; Clark, J.C.; Fawley, W.M.; Orzechowski, T.J.; Paul, A.C.; Prosnitz, D.; Scharlemann, E.T. (Lawrence Berkeley Lab., Univ. of California, 1 Cyclotron Road, Mail Stop: B52B, Berkeley, CA 94720). pp 61-73 of High intensity laser processes. Alcock, A.J. Bellingham, WA; SPIE Society of Photo-Optical Instrumentation Engineers (1986). (CONF-860620—). Contract W-7405-ENG-48;AC03-76SF00098.

From Society of Photo-Optical Instrumentation Engineers international symposium: topics in optical and optoelectronic applied sciences and engineering; Quebec City, Canada (2 Jun 1986).

At the Lawrence Livermore National Laboratory, a pulsed electromagnetic wiggler has been coupled to the Experimental Test Accelerator forming the Electron Laser Facility. This is a single-pass Free-Electron Laser which, because the wiggler excitation can be varied, can operate over a wide frequency range. Efficiency of conversion of electron beam to microwave power is 7%. This new power source is being used in a collateral program for developing and testing structures suitable for a Two-Beam Accelerator. The Two-Beam Accelerator shows much promise for achieving the high average accelerating gradients, e.g., ≧250 MV/m, required in such next-generation electron accelerators as 1 TeV on 1 TeV linear colliders. In this paper, the results of recent tests characterizing the Free-Electron Laser are summarized. Also, progress in the fabrication and testing of key Two-Beam Accelerator hardware components are reviewed. Finally, Two-Beam Accelerator problem areas are discussed.

25465 **Studies of photoexcitation for extreme ultraviolet lasers.** Wisoff, P.J.K. Stanford, CA; Stanford Univ. (1986). 125p. University Microfilms Order No. 87-00,835.

Thesis (Ph. D.).

A laser-produced plasma facility was constructed that is suitable for exciting very high densities of excited state ions and atoms for the production of extreme-ultraviolet lasers. This facility includes a high power Nd:YAG-glass system, which generates laser pulses at 1.06 μm with a duration of 0.1 to 1 ns with energies of 2 to 20 Joules, and a dye laser system which can produce tunable laser pulses of 20 ps duration with energies of 1 to 3 mJ. A new synchronously pumped oscillator was designed for the dye laser system to provide high power, broadly tunable, picosecond pulses would be appropriate for transferring or measuring excited-state populations. This facility has been used to generate x-rays from a laser-produced plasma on a tantalum target in order to photoionize core electrons in Li vapor to produce excited Li ions. Measurements of the $Li^+(1s2s)^3S$ metastable ion and $Li^+(1s3s)^3S$ ion densities were performed to study the dependences of these populations on time, Li pressure, laser energy, and distance from the target. Metastable densities as high as 3×10^{15} cm^{-3} were achieved in the $Li^+ (1s2d)^3S$ state at 2 mm from the target with 2.3 joules of laser energy.

25466 **High-speed cell and chromosome analysis through laser interrogation.** Dean, P.N. (Lawrence Livermore National Lab., Biomedical Sciences Div., P.O. Box 5508, Livermore, CA). pp 148 of Conference record of the 1985 IEEE conference on lasers and electro-optics. Piscataway, NJ; IEEE Service Center (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

This paper describes the physical principles involved in making measurements and several instruments currently in use in biomedical research.

25467 **Slab geometry laser. Part I. Theory.** Eggleston, J.M.; Kane, T.J.; Kuhn, K.; Unternahrer, J.; Byer, R.L. (Mathematical Sciences N.W. Inc., Bellevue, WA). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* QE-20: No. 3, 289-301(Mar 1984).

Slab geometry solid-state lasers offer significant performance improvements over conventional rod geometry lasers. The authors present a detailed theoretical description of the thermal, stress, and beam propagation characteristics of a slab laser. Their analysis includes consideration of the effects of the zig-zag optical path which eliminates thermal and stress focusing and reduces residual birefringence. 26 references, 3 figures.

25468 **Review of ultraviolet damage threshold measurements at Lawrence Livermore National Laboratory.** Lowdermilk, W.H.; Milam, D. (Lawrence Livermore National Lab., Mail Stop L-490, P.O. Box 5508, Livermore, CA 94550). pp 143-162 of Excimer lasers, their applications, and new frontiers in lasers. Vol. 476. Waynant, R.W. Bellingham, WA; SPIE Society of Photo-Optical Instrumentation Engineers (1984). (CONF-8404124—).

From SPIE technical symposium; Arlington, VA, USA (29 Apr 1984).

The results of damage threshold measurements made at LLNL using ultraviolet wavelength laser pulses are reviewed. Measurements were made with pulses from a krypton fluoride laser with wavelength of 248 nm and pulse duration of 20 ns and with

Nd-glass laser pulses converted to the third harmonic wavelength of 355 nm with duration of 0.6 ns. Measurements are presented for transparent window materials, crystals for harmonic generation, single layer dielectric films of oxide and fluoride materials and multilayer high reflectivity and antireflective coatings.

4204 Heat Transfer And Fluid Flow

REFER ALSO TO CITATION(S) 24480, 24856, 24893, 25426, 25442

25469 **(AD-A—176281/4/XAB) Modification and improvement of software for modeling multidimensional reacting fuel flow. Final technical report, 15 July 1985-13 February 1986.** Angevine, M.; Smooke, M.; Keyes, D. (Scientific Computing Associates, Inc., New Haven, CT (USA)). Nov 1986. 48p. NTIS, PC A03/MF A01.

This report describes a project to develop computational models of reacting flows that combine the efforts of detailed chemical kinetics with complex fluid mechanics to form an integrated analytical code. Initial efforts were aimed at solutions for counterflow diffusion flames; this model incorporated both finite rate chemistry and complex kinetic-theory transport effects. Next, a flame-sheet model was used to provide improved starting estimates for the calculations. A combination of time integration and Newton's method was used to solve the flame-sheet and finite-rate equations. Success with the one-dimensional model led to the development of a more-generalized two-dimensional model. A parallel effort investigated ways to improve the computational efficiency of the primitive variable implementation of the TEACH code. Further generalization of these ideas to axisymmetric (laminar and turbulent) diffusion flame studies will be the focus of a follow-on project.

25470 **(CONF-861204—7) A generalized correlation for condensation on vertical fluted surfaces.** Panchal, C.B. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006984.

From 4. Miami international symposium on multi-phase transport and particulate phenomena; Miami Beach, FL, USA (15 Dec 1986).

A correlation was developed for laminar film condensation on vertical fluted surfaces. The theoretical analysis of Panchal and Bell was used for defining important physical property groups. The experimental data of Combs et al. were used to validate the proposed correlation. The experimental data base used in the present study included four flute geometries that could be approximated to cosine type flutes and seven fluids. The resulting correlation can predict the average condensate heat transfer coefficient within +-20%.

25471 **(N—87-11963) On the Maxwellian distribution, symmetric form, and entropy conservation for the Euler equations.** Deshpande, S.M. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Nov 1986. 30p. (NASA-TP—2583; L—16036; NAS—1.60:2583). NTIS, PC A03/MF A01.

The Euler equations of gas dynamics have some very interesting properties in that the flux vector is a homogeneous function of the unknowns and the equations can be cast in symmetric hyperbolic form and satisfy the entropy conservation. The Euler equations are the moments of the Boltzmann equation of the kinetic theory of gases when the velocity distribution function is a Maxwellian. The present paper shows the relationship between the symmetrizability and the Maxwellian velocity distribution. The entropy conservation is in terms of the H-function, which is a slight modification of the H-function first introduced by Boltzmann in his famous H-theorem. In view of the H-theorem, it is suggested that the development of total H-diminishing (THD) numerical methods may be more profitable than the usual total variation diminishing (TVD) methods for obtaining wiggle-free solutions.

25472 **(N—87-15272) Low heat transfer oxidizer heat exchanger design and analysis. Topical report, October 1985-October 1986.** Kanic, P. G.; Kmiec, T. D.; Peckham, R. J. (Pratt and Whitney Aircraft Group, West Palm Beach, FL (USA)). Jan 1987. 51p. (NASA-CR—179488; NAS—1.26:179488; FR—19135-2). NTIS, PC A04/MF A01.

The RL10-IIB engine, a derivative of the RLIO, is capable of multi-mode thrust operation. This engine operates at two low thrust levels: tank head idle (THI), which is approximately 1 to 2 percent of full thrust, and pumped idle (PI), which is 10 percent of full thrust. Operation at THI provides vehicle propellant settling thrust and efficient engine thermal conditioning; PI operation provides vehicle tank pre-pressurization and maneuver thrust for log-g deployment. Stable combustion of the RL10-IIB engine at THI and PI thrust levels can be accomplished by providing gaseous oxygen at the propellant injector. Using gaseous hydrogen from the thrust chamber jacket as an energy source, a heat exchanger can be used to vaporize liquid oxygen without creating flow instability. This report summarizes the design and analysis of a United Aircraft Products (UAP) low-rate heat transfer heat exchanger concept for the RL10-IIB rocket engine. The design represents a second iteration of the RL10-IIB heat exchanger investigation program. The design and analysis of the first heat exchanger effort is presented in more detail in NASA CR-174857. Testing of the previous design is detailed in NASA CR-179487.

25473 **(N—87-15441) Two- and three-dimensional viscous computations of a hypersonic inlet flow.** Kunik, W. G.; Benson, T. J.; Ng, W.F.; Taylor, A. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Jan 1987. 17p. (NASA-TM—88923; E—3356; NAS—1.15:88923; AIAA—87-0283; CONF-870133—5). NTIS, PC A02/MF A01.

From 25. AIAA aerospace sciences meeting; Reno, NV, USA (12 Jan 1987).

Sponsored by AIAA.

The three-dimensional parabolized Navier-Stokes code has been used to investigate the flow through a Mach 7.4 inlet. A two-dimensional parametric study of grid resolution, turbulence modeling and effect of gamma has been done and compared with experimental results. The results show that mesh resolution of the shock waves, real gas effects and turbulence length scaling are very important to get accurate results for hypersonic inlet flows. In addition a three-dimensional calculation of the Mach 7.4 inlet has been done on a straight sideplate configuration. The results show that the glancing shock/boundary layer interaction phenomena causes significant three-dimensional flow in the inlet.

25474 (N—87-16742, pp vp) **Advanced thermal energy management: a thermal test bed and heat pipe simulation.** Barile, R. G. Nov 1986. NTIS, PC A99/MF E04. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—).

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

Work initiated on a common-module thermal test simulation was continued, and a second project on heat pipe simulation was begun. The test bed, constructed from surplus Skylab equipment, was modeled and solved for various thermal load and flow conditions. Low thermal load caused the radiator fluid, Coolanol 25, to thicken due to its temperature avoided by using a regenerator-heat-exchanger. Other possible solutions modeled include a radiator heater and shunting heat from the central thermal bus to the radiator. Also, module air temperature can become excessive with high avionics load. A second preoject concerning advanced heat pipe concepts was initiated. A program was written which calculates fluid physical properties, liquid and vapor pressure in the evaporator and condenser, fluid flow rates, and thermal flux. The program is directed to evaluating newer heat pipe wicks and geometries, especially water in an artery surrounded by six vapor channels. Effects of temperature, groove and slot dimensions, and wick properties are reported.

25475 **Study of nonequilibrium dispersed two phase flow.** Reyes, J.N. Jr. College Park, MD; Univ. of Maryland (1986). 145p. University Microfilms Order No. 86-29,003.

Thesis (Ph. D.).

Understanding the behavior of liquid droplets in a superheated steam environment is essential to the accurate prediction of nuclear fuel rod surface temperatures during the blowdown and reflood phase of a loss-of-coolant-accident (LOCA). In response to this need, this treatise presents several original and significant contributions to the field of thermofluid physics. The research contained herein presents a statistical derivation of the two-phase mass, momentum, and energy-conservation equations using a droplet continuity equation analogous to that used in the Kinetic Theory of Gases. Unlike the Eulerian volume and time-averaged conservation equations generally used to describe dispersed two-phase flow behavior, this statistical averaging approach results in an additional mass momentum or energy term in each of the respective conservation equations. Further, this study demonstrates that current definitions of the volumetric vapor generation rate used in the mass conservation equation are inappropriate results under certain circumstances. The mass conservation equation derived herein is used to obtain a new definition for the volumetric vapor-generation rate. Last, a simple two phase phenomenological model, based on the statistically averaged conservation equations, is presented and solved analytically. It is shown that the actual quality and vapor temperature, under these circumstances, depend on a single dimensionless group.

4205 Materials Testing

REFER ALSO TO CITATION(S) 24478, 24539, 24785, 24797, 24821, 24835, 25164, 25165, 25166, 25203, 25252, 25558

25476 (AD-A—175487/8/XAB) Photothermal imaging of defects in metals and ceramics. Final report, 1 September 1983-31 August 1986. Murphy, J.C.; Aamodt, L.C. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Oct 1986. 235p. (JHU/APL/RC-TPS—012). NTIS, PC A11/MF A01.

Photothermal - or thermal-wave - imaging is a new technique for the characterization and nondestructive evaluation of materials. This report describes developments in the method, theory, and application of thermal-wave imaging techniques. A theory of multilayer films was developed which showed that both thermal (and for optical sources) optical-boundary-condition reflections contribute to the temperature field within the specimen and, hence, affect the ability of thermal-wave imaging methods to determine the depth (or thickness) of buried flaws (or layers). The analysis made shows that thermal barriers affecting heat flow in a heterogeneous material are of two types, one depending exclusively on thermal properties and the other depending on both thermal and optical properties. Applications of thermal-wave imaging included grain-boundary studies in metals, studies of void location and sizing, and closed-crack visualization using both thermal and thermoelastic methods. Thermal-wave imaging is a pervasive technique for nondestructive evaluation, encompassing a variety of experimental configurations, each supplying different physical information; three different types of processes are effective in creating thermal images; this technique is suitable for studying the microstructure of a variety of materials; thermoelastic mechanisms are operative in thermal-wave imaging; and momentum processes are ineffective in producing thermal images using particle-beam sources. A new thermal-wave imaging technique using an ion beam as the excitation source was developed.

25477 (EPRI-NP—4848) Improvement of a portable high-energy radiographic inspection system: Final report. Owen, R.D. (Schonberg Radiation Corp., Santa Clara, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 118p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920298.

This report describes the development of miniaturized linear accelerator (MINAC) technology, including descriptions of all major developments sponsored by EPRI subsequent to previously sponsored work. In addition, this report describes MINAC-related developments in both real-time x-ray imaging and radiographic image data processing systems which were sponsored by EPRI concurrently. The objectives of this program have been to achieve modifications identified as desirable improvements to the basic "MINAC 3" equipment; to expand the range and effectiveness of MINAC applications through design improvements, achievement of wider energy/output capabilities, and the development of suitable imaging and digital processing technologies; and to provide technical information on high-energy radiographic equipment useful to scientists, educators, institutions, NDE technicians and others who may benefit from detailed information on the special equipment. Program, equipment and technical descriptions are followed by conclusions and recommendations for future work.

25478 (EPRI-NP—5086) Utility guide to advanced ultrasonic systems for preservice and in-service inspections: Topical report. Neeley, V.I. (VinTek, Inc., Richland, WA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 101p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920312.

This report addresses the need of utility NDE managers to have available guidelines for evaluating the merits of using advanced (UT) inspection systems. A large number of advanced UT systems are now commercially available and boast a variety of capabilities. These systems are called "advanced" because they employ state of the art electronics, computers, and signal processing and imaging software. The guide includes systems that have applications to the inspection of boiling water reactor (BWR) piping. Information is presented in tabular form to facilitate simple comparisons between systems and to simplify access to system hardware and software requirements. A tutorial section discusses general ultrasonic inspection theory and gives a perspective from which a manager can view advanced systems. The dollars and cents of using an advanced UT system versus the standard manual mode inspection is also discussed. The results of a survey of utilities, service and vendor organizations are presented, cast in a benefit-to-cost framework. An example of specifications that a system should meet is also given and is modeled along the lines of a purchase order specification.

25479 (PNL—6143) Federal laboratory nondestructive testing research and development applicable to industry. Smith, S.A.; Moore, N.L. (Pacific Northwest Lab., Richland, WA (USA)). Feb 1987. Contract AC06-76RL01830. 259p. NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE87008351.

This document presents the results of a survey of nondestructive testing (NDT) and related sensor technology research and development (R & D) at selected federal laboratories. Objective was to identify and characterize NDT activities that could be applied to improving energy efficiency and overall productivity in US manufacturing. Numerous federally supported R & D programs were identified in areas such as acoustic emissions, eddy current, radiography, computer tomography and ultrasonics. A Preliminary Findings Report was sent to industry representatives, which generated considerable interest.

25480 (UCRL—53771) An improved method for simulating radiographs. Laguna, G.W. (Lawrence Livermore National Lab., CA (USA)). 30 Sep 1986. Contract W-7405-ENG-48. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006588.

The parameters involved in generating actual radiographs and what can and cannot be modeled are examined in this report. Using the spectral distribution of the radiation source and the mass absorption curve for the material comprising the part to be modeled, the actual amount of radiation that would pass through the part and reach the film is determined. This method increases confidence in the results of the simulation and enables the modeling of parts made of multiple materials. (LEW)

4208 Electronic Circuits And Devices

REFER ALSO TO CITATION(S) 24835, 25288, 25298, 25335, 25643, 25704, 25705, 25706, 25709, 25710, 25722, 25962, 25963

25481 (LBL—22581) **The structure of Al/GaAs interfaces.** Liliental-Weber, Z.; Nelson, C.; Gronsky, R.; Washburn, J.; Ludeke, R. (Lawrence Berkeley Lab., CA (USA); IBM Watson Research Center, Yorktown Heights, NY (USA)). Dec 1986. Contract AC03-76SF00098. 8p. (CONF-861207—95). NTIS, PC A02. File Number DE87007181.

From Materials Research Society fall meeting; Boston, MA, USA (1 Dec 1986).

The structure of Al/GaAs interfaces was investigated by high resolution electron microscopy. The Al layers were deposited in a molecular beam epitaxy chamber with a vacuum base pressure of $<1 \times 10^{-8}$ Pa. The GaAs substrate temperature varied during Al deposition from -30°C to 400°C. Deposition of Al on cold substrates ≦25°C resulted in epitaxial growth of (001) Al on (001) GaAs. Droplets of Ga were observed in samples with the substrate temperature at -30°C (1 x 2) and 0°C (c(2 x 8)). Postannealing of the last sample caused formation of the AlGaAs phase. Deposition of Al on hot substrates (150°C and 400°C) resulted in the formation of the AlGaAs phase, which separated (110) oriented Al from (001) GaAs.

25482 (SAND—87-0354) **Pulsed Nd:YAG laser closure welding of the MC3593/3594 relay.** Fuerschbach, P.W. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007825.

The pulsed Nd:YAG laser welding process is often chosen today for closure welding of small hermetically sealed electrical devices. This is because it is a high power density welding process that can minimize total heat input and therefore is less likely to damage heat sensitive components. The effect of the pulsed Nd:YAG laser welding parameters on the incidence of glass-to-metal seal cracking and on the weld fusion zone dimensional parameters for the MC 3593/3594 relays has been determined. Fluctuations in weld penetration in production relays have been attributed to variability in sharp focus positioning. A large increase in blowholes and porosity in the fusion zone has been traced to the inadvertent substitution of 304 stainless steel for 304L stainless steel header material. The blowholes and porosity are thought to result from a carbon-oxygen gas reaction in the weld pool due to the presence of a 4% oxygen atmosphere and the increased carbon content of the 304 stainless steel.

25483 (SAND—87-0386C) **Epitaxial semiconductor optical interference devices.** Gourley, P.L.; Biefeld, R.M.; Drummond, T.J.; Zipperian, T.E. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 23p. (CONF-870385—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006890.

From SPIE conference on growth of compound semiconductors; Bay Point, FL, USA (22 Mar 1987).

A new class of single-crystal, semiconductor optical interference devices is described. The basic physics governing their operation and materials and growth methods to implement them are summarized. Recent experimental results for epitaxial optical filters, monolithic integration, and tunability are discussed.

25484 (SAND—87-0625C) **Electrochemical adjustment of thin film Ti-Pd resistors.** Sharp, D.J.; Norwood, D.P. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 23p. (CONF-870388—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007392.

From International conference on metallurgical coatings; San Diego, CA, USA (23 Mar 1987).

Thin multilayered films consisting of tantalum nitride (Ta_2N), titanium, palladium, and gold are used at Sandia to fabricate hybrid microcircuits. From these stock multilayered composites, various circuits can be selectively etched and patterned to provide conductors and two levels of resistor patterns. The tantalum nitride is used to form resistor structures having values ranging from about 20 to 50,000 ohms. In order to provide resistors having values of about 1 to 4 ohms, the palladium, with its underlying titanium and Ta_2N layers, is used; these were designated as Ti-Pd resistors. Low resistivity tuned strip lines, for example, have this need. Present HMC technology typically limits the fabrication precision of thin film resistors to accuracies of 20 or 30%. Laser trimming is typically used to adjust out-of-tolerance resistors, however, in the case of strip line resistor applications this introduces undesirable variations in the impedance. We have completed a study of the use of an electrochemical probe which can be used to selectively deposit gold or, alternatively, remove palladium from the surface of the palladium composite film resistors described above. This permits resistor adjustment to either higher or lower values and does not produce discontinuities which occur with laser trimming. The process is similar in its result to that observed in the electrochemical or anodic trimming of Ta_2N resistors and is used to achieve practical tolerances of about 5% in Ti-Pd resistors. Studies describing accelerated life aging, temperature coefficient of resistance changes, and final adjustment precision are discussed.

25485 (UCRL—15884) **Validation tests of the DIODE2D code.** Wahlstrand, K.; McDonald, J.; Goplen, B. (Mission Research Corp., Alexandria, VA (USA); Lawrence Livermore National Lab., CA (USA)). Oct 1986. Contract W-7405-ENG-48. 78p. (MRC/WDC-R—115). NTIS MF A01; 2; GPO Dep. File Number DE87007060.

Validation tests have been performed on the two-dimensional semiconductor code, DIODE2D. Comparisons were made with analytical models to validate various simulation features in the electronic and thermal algorithms, external circuit scaling, and cylindrical coordinates. Also, a comparison was made with results from another, one-dimensional code for a forward-biased PIN diode. Finally, rf simulations were performed on the PIN diode. In all cases, acceptable simulation accuracy was achieved.

25486 **Starting conditions for relativistic backward wave oscillators at low currents.** Swegle, J.A. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physics of Fluids;* 30: No. 4, 1201-1211(Apr 1987). Contract AC04-76DP00789.

This paper contains a theoretical treatment of the start oscillation condition for backward wave oscillators with rippled wall slow wave structures, driven by relativistic, low current, annular electron beams. In the low current, or Compton, limit of device operation, this condition amounts to setting a minimum value on the product of the beam current and the cube of the structure length; above the minimum value, the device will spontaneously break into oscillations, even in the absence of an input signal. Also computed is the small signal growth rate of the oscillations, which is shown to be less than the single mode growth rate for an infinitely long structure. Approximate closed form expressions are found in the limit of shallow structure ripples, while numerical results are presented for deeper wall ripples.

25487 (RFP-Trans—466) **Method for removing coated films such as photoresist films.** Hayashi, Shuzei. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant; Nippon Shinku Gijutsu K.K., Chigasaki-shi). Apr 1987. Contract AC04-76DP03533. Translated from Japanese Kokai Patent Publication No. 60-43830 (1985). 7p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008182.

Disclosed is a method for removing coated films such as photoresist film. CO_2 particles are injected and directed against the coated film, which has been prepared directly or indirectly on a substrate surface.

25488 **Farey-fraction frequency modulation in the neuron like output of silicon p-i-n diodes at 4.2 K.** Coon, D.D.; Ma, S.N.; Perera, A.G.U. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). *Physical Review Letters;* 58: No. 11, 1139-1142(16 Mar 1987).

The first temporal analysis of spontaneous pulsing of dc biased, p-i-n diodes in RC circuits is reported. Time intervals T/sub n/ between successive pulses in spike trains with durations up to 30 h are analyzed as a function of n. Temporal patterns depend on bias voltage and are characterized by symmetric sets of Farey-fraction frequencies associated with remarkably narrow peaks in power spectra. Resolution permitted identification of 115 of the 129 Farey fractions with period $\leqq 40$. A rule involving fractions appearing in this system and other nonlinear systems is proposed.

25489 Electronic imaging system and technique. Bolstad, J.O. (to Dept. of Energy, Washington, DC). US Patent 4,649,426. 10 Mar 1987. Filed date 12 Jun 1984. vp.

A system is described for viewing a weld site obscured by an intense plasma or flame comprising: a pulsed light source providing an illumination beam for illuminating the weld site, the peak brightness of the light reflected from the weld site being greater than the brightness of the intense plasma or flame; an electronic image sensor for detecting a pulsed image of the illuminated weld site, the sensor operating as a high-speed shutter; and electronic means for synchronizing the shutter operation with the pulsed light source.

25490 Process for obtaining multiple sheet resistances for thin film hybrid microcircuit resistors. Norwood, D.P. (to Dept. of Energy). US Patent Application 6-894,145. 7 Aug 1986. 31p. Contract AC04-76DP00789. DE87007205 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007205.

A standard thin film circuit containing Ta_2N (100 ohms/square) resistors is fabricated by depositing on a dielectric substrate successive layers of Ta_2N, Ti and Pd, with a gold layer to provide conductors. The addition of a few simple photoprocessing steps to the standard TFN (thin film network) manufacturing process enables the formation of Ta_2N + Ti (10 ohms/square) and Ta_2N + Ti + Pd (1 ohm/square) resistors in the same otherwise standard thin film circuit structure. All three types of resistors are temperature-stable and laser-trimmable for precise definition of resistance values.

25491 Polysilicon photoconductor for integrated circuits. Hammond, R.B.; Bowman, D.R. (to Dept. of Energy). US Patent Application 6-888,311. 22 Jul 1986. 18p. Contract W-7405-ENG-36. DE87007199 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007199.

A photoconductive element of polycrystalline silicon is provided with intrinsic response time which does not limit overall circuit response. An undoped polycrystalline silicon layer is deposited by LPCVD to a selected thickness on silicon dioxide. The deposited polycrystalline silicon is then annealed at a selected temperature and for a time effective to obtain crystal sizes effective to produce an enhanced current output. The annealed polycrystalline layer is subsequently exposed and damaged by ion implantation to a damage factor effective to obtain a fast photoconductive response.

25492 Method and apparatus for controlling multiple motors. Jones, R.G.; Kortegaard, B.L.; Jones, D.F. (to Dept. of Energy). US Patent Application 6-888,313. 22 Jul 1986. 61p. Contract W-7405-ENG-36. DE87007200 NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007200.

A method and apparatus are provided for simultaneously controlling a plurality of stepper motors. Addressing circuitry generates address data for each motor in a periodic address sequence. Memory circuits respond to the address data for each motor by accessing a corresponding memory location containing a first operational data set functionally related to a direction for moving the motor, speed data, and rate of speed change. First logic circuits respond to the first data set to generate a motor step command. Second logic circuits respond to the command from the first logic circuits to generate a third data set for replacing the first data set in memory with a current operational motor status, which becomes the first data set when the motor is next addressed.

25493 Cermet insert high voltage holdoff improvement for ceramic/metal vacuum devices. Ierna, W.F. (to Dept. of Energy). US Patent Application 6-838,493. 11 Mar 1986. 23p. Contract AC04-76DP00656. DE87007217 NTIS, PC A02/MF A01; GPO Dep. File Number DE87007217.

An improved metal-to-ceramic seal is provided wherein the ceramic body of the seal contains an integral region of cermet material in electrical contact with the metallic member, e.g., an electrode, of the seal. The seal is useful in high voltage vacuum devices, e.g., vacuum switches, and increases the high-voltage holdoff capabilities of such devices. A method of fabricating such seals is also provided.

25494 A process for the chemical preparation of high-field ZnO varistors. Brooks, R.A.; Dosch, R.G.; Tuttle, B.A. (to Dept. of Energy). US Patent Application 6-830,812. 19 Feb 1986. 24p. Contract AC04-76DP00789. DE87007299 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007299.

Chemical preparation techniques involving co-precipitation of metals are used to provide microstructural characteristics necessary in order to produce ZnO varistors and their precursors for high field applications. The varistors produced have homogeneous and/or uniform dopant distributions and a submicron average grain size with a narrow size distribution. Precursor powders are prepared via chemical precipitation techniques and varistors made by sintering uniaxially and/or isostatically pressed pellets. Using these methods, varistors were made which were suitable for high-power applications, having values of breakdown field, E/sub B/, in the 10 to 100 kV/cm range, $\alpha > 30$ and densities in the range of 65 to 99% of theoretical, depending on both composition and sintering temperature.

4209 Waste Processing Plants And Equipment

REFER ALSO TO CITATION(S) 25169

4210 Combustion Systems

REFER ALSO TO CITATION(S) 24462, 24481, 24483, 24488, 24490, 24492, 24494, 24495, 24541, 24548, 24549, 24551, 24561, 24562, 24563, 24564, 24565, 24566, 24567, 24568, 24569, 24570, 24571, 24572, 24573, 24574, 24575, 24576, 24577, 24578, 24579, 24580, 24581, 24582, 24583, 24584, 24585, 24586, 24587, 24588, 24589, 24590, 24591, 24776, 24835, 25262, 25472, 25509, 25510, 25823

25495 (BNL—39265) **Results on studies of soot production and fouling in oil-fired condensing systems.** Butcher, T.; Celebi, Y.; Piraino, M.; McDonald, R. (Brookhaven National Lab., Upton, NY (USA)). Jan 1986. Contract AC02-76CH00016. 21p. (CONF-860106—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006463.

From ASHRAE semi-annual meeting; San Francisco, CA, USA (19 Jan 1986).

The development of condensing heat exchangers for oil-fired heating equipment would yield a significant improvement in thermal efficiency. Soot production by oil burners, however, could lead to fouling problems in these systems. Results are reported on tests done to evaluate the effect of operating conditions on start-up and shutdown smoke production in both noncondensing and condensing furnaces.

25496 (CONF-8604156—, pp 313-321) **Technologies to increase the efficient use of energy in the process industries.** Pohl, J.H.; Lanier, W.S.; Keller, J.; Patton, J.; Jain, R. (Energy and Environmental Research Corp., Irvine, CA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

This study identified innovative research areas which will conserve industrial energy and improve fuel flexibility within the next ten years. The approach taken was, first to identify major industrial users of energy. Second, to characterize industrial processes so that research work on specific processes could be extended to other processes. Third, to identify research topics, establish the status of the technology, investigate technological and institutional barriers to implementing the technology, and to evaluate the savings and economics of installing the technology. Initially, 144 potential research topics were identified. These were screen to 32 topics. The 32 research topics were evaluated for energy saving and economics of implementation. Fifteen research topics which could economically save industrial energy and improve fuel flexibility were identified. Of these, topics two (1) combustion of low Btu wastes; (2) furnace design, heat transfer and mixing patterns; were more attractive economically than others and could save 500 BOE/yr-dollar research and 350 BOE/yr-dollar research, respectively. Immediate consideration could be given to funding these two topics. 4 references, 3 figures, 4 tables.

25497 (CONF-8604156—, pp 323-325) **Combustion system requirements for advanced gas-fired processes.** Knowles, D.F. (Gas Research Institute, Chicago, IL). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Gas Research Institute is supporting the development of innovative advances in the state-of-the-art for natural gas fired industrial process equipment. The keys to maintaining and expanding the competitiveness of gas equipment are improved productivity and flexibility and higher temperature capability. The paper explains specific process developments and describes the advances required in combustion technology.

25498 (CONF-8604156—, pp 329-334) **Low NO/sub x/, low temperature oxygen-fuel burner.** Anderson, J.E. (Union Carbide Corp., Tarrytown, NY). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

The maximum fuel savings via oxygen enrichment is often achieved using up to 100% oxygen. High oxygen concentrations in a conventional burner, however, pose problems. The flame temperature is high (above 5000°F) leading to local overheating and high thermal NO/sub x/. In addition, the substantial reduction in gas flow rate through the furnace when converting from air to oxygen reduces the internal gas recirculation resulting in large temperature gradients and less uniform heating of the charge. These problems are overcome in a new burner in which oxygen is fed through a number of nozzles surrounding a central fuel jet. The oxygen jets are at a sufficient distance from the central fuel jet so that furnace gases are aspirated into the oxygen jets before mixing with the fuel. By proper design, the concentration of oxygen mixed with furnace gases can be 20% or less before interacting with the fuel. The final flame temperature is substantially below that for conventional burners and NO/sub x/ levels are one to two orders of magnitude below that for federal codes for fuel gas. Gas mixing and recirculation within the furnace is accomplished with oxygen jets at very high velocity, of the order of 1000 ft/sec. 4 references, 6 figures.

25499 (CONF-8604156—, pp 335-343) **Burner/atomizer requirements for combustion of waste fuels.** Santoleri, J.J. (Four Nines, Inc., Plymouth Meeting, PA). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Increased energy costs created by the 1973-1974 oil crisis forced many plant owners to look at many energy conservation methods. Included in these were the use of plant waste products (liquids, sludges, and solids) with reasonable heating value. However, this presented many problems in materials handling, especially with the highly viscous liquids and sludges. It also presented problems with the atomizers, the burners, refractory materials, as well as heat recovery equipment. As a result, some plant operators continued to have this material hauled away rather than utilize its energy value. Technology has been developed in the incinerator industry to adequately handle these materials, burn them, and reach the 99.99% destruction of the toxic, hazardous components. The technology developed for these burners and atomizers is available to combust the more difficult to handle tars (viscosities to 1000 cp) and waste fuels. The energy available from these materials can be utilized in the plant operations. This paper will discuss the design features required in a high intensity burner capable of burning gaseous wastes with heating values as low as 90 Btu/cu. ft. as well as liquid wastes with heating values to 4500 Btu/lb. Problem areas that should be reviewed carefully in the design stage of a system will also be discussed. 6 references, 6 figures.

25500 (CONF-8604156—, pp 345-350) **Fuel staging burners for NO/sub x/ control.** Waibel, R.; Nickeson, D.; Radak, L.; Boyd, W. (John Zink Co., Tulsa, OK). 1986. American Society for Metals, Metals Park, OH 44073. File Number TI87004152.

From Symposium on industrial combustion technologies; Chicago, IL, USA (29 Apr 1986).

Low excess air, flue gas recirculation, air staging and burners-out-of-service have all been utilized extensively to reduce the emissions of NO/sub x/ from industrial burners and utility boilers. New restrictions in parts of the US and elsewhere, however, have defined levels that are more and more difficult to achieve. Specifications of 75 ppm and even 40 ppm as the maximum allowable concentration are becoming common. Fuel staging has proven to be able to achieve these more restrictive NO/sub x/ levels in most cases. The results of an extensive research and development program are presented in which the fuel staging technique has been applied to burners for industrial and utility boilers. Burners ranging in size from 25 MMBtu/hr to 100 MMBtu/hr were used in the study. The benefits of combining fuel staging and flue gas recirculation are also presented. 14 figures.

25501 **(N—87-11858) User's manual for a TEACH computer program for the analysis of turbulent, swirling reacting flow in a research combustor.** Chiappetta, L.M. (United Technologies Research Center, East Hartford, CT (USA)). Sep 1983. 120p. (NASA-CR—179547; NAS—1.26:179547; R—83-915540-27). NTIS, PC A06/MF A01.

Described is a computer program for the analysis of the subsonic, swirling, reacting turbulent flow in an axisymmetric, bluff-body research combustor. The program features an improved finite-difference procedure designed to reduce the effects of numerical diffusion and a new algorithm for predicting the pressure distribution within the combustor. A research version of the computer program described in the report was supplied to United Technologies Research Center by Professor A. D. Gosman and his students, R. Benodeker and R. I. Issa, of Imperial College, London. The Imperial College staff also supplied much of the program documentation. Presented are a description of the mathematical model for flow within an axisymmetric bluff-body combustor, the development of the finite-difference procedure used to represent the system of equations, an outline of the algorithm for determining the static pressure distribution within the combustor, a description of the computer program including its input format, and the results for representative test cases.

25502 **(N—87-15271) Thermal analysis and design of a cooling system for a Mach 14 nozzle. Final report, February 1986-January 1987.** Mullisen, R.; Kaste, K. (California Polytechnic State Univ., San Luis Obispo (USA)). Jan 1987. 99p. (NASA-CR—180098; NAS—1.26:180098). NTIS, PC A05/MF A01.

The analysis and design of a Mach 14 converging diverging nozzle wall liner is provided. The analysis indicates that: no fin on the coolant side of the nozzle wall is optimum, the thermal stresses are dominant, and the critical area is very near the throat. The molybdenum alloy TZM, with a wall thickness of 2.0 mm in the throat area, appears to be the only material capable of meeting design requirements. Additionally, cooling water at 2000 psia with a flow velocity of 25 m/s in the coolant passages is required.

25503 **(N—87-15491) Creep fatigue life prediction for engine hot section materials (ISOTROPIC). Interim report.** Nelson, R. S.; Schoendorf, J. F.; Lin, L. S. (Pratt and Whitney Aircraft, East Hartford, CT (USA)). Dec 1986. 162p. (NASA-CR—179550; NAS—1.26:179550). NTIS, PC A08/MF A01.

The specific activities summarized include: verification experiments (base program); thermomechanical cycling model; multiaxial stress state model; cumulative loading model; screening of potential environmental and protective coating models; and environmental attack model.

25504 (N—87-16065) **Potential propellant storage and feed systems for space station resistojet propulsion options. Final report.** Bader, C. H. (Sverdrup Technology, Inc., Cleveland, OH (USA)). Jan 1987. 63p. (NASA-CR—179457; E—3366; NAS—1.26:179457). NTIS, PC A04/MF A01.

The resistojet system has been defined as part of the baseline propulsion system for the initial Operating Capability Space Station. The resistojet propulsion module will perform a reboost function using a wide variety of fluids as propellants. There are many optional propellants and propellant combinations for use in the resistojet including (but not limited to): hydrazine, hydrogen, oxygen, nitrogen, water, carbon dioxide, and methane. Many different types of propulsion systems have flown or have been conceptualized that may have application for use with resistojets. This paper describes and compares representative examples of these systems that may provide a basis for space station resistojet system design.

25505 (NP—7751732, pp 135-213) **Alternative fluidized-bed furnaces for a coal-fueled heat-and-power plant.** 1982. (In German). NTIS (US Sales Only), PC A13/MF A01. File Number DE87751732.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.1. Energy supply.

In the framework of comparative investigations on the use of gas, electricity and district heat in the Rhine and Neckar region, a second contribution dealing with energy supply reports on alternative fluidized-bed combustion systems for a coal-fired thermal power plant. Structure and projecting of fluidized bed combustion as well as executed plants are dealt with in detail. The plant concepts are evaluated (concepts with stationary atmospheric, with circulating and with supercharged fluidized bed combustion). Furthermore steam generators are compared with alternative combustion systems (process, economic efficiency). Finally cost development is pointed out as a function of steam generating capacity (calculation equations, cost types). (HWJ).

25506 (STF—25A85011) **Denseness of chimneys. A laboratory and field investigation on the conditions at chimneys and fireplaces.** Hansen, F.H. (SINTEF, Trondheim (Norway)). May 1986. 86p. (In Norwegian). NTIS (US Sales Only), PC A05/MF A01. File Number DE87751697.

The report deals with an investigation on the leakage of stove pipes and chimneys. The importance of impervious conditions in connection with damages is also discussed. The results from this investigation form the basis of building regulations on such structures in Norway. The construction qualities and also chimney fires caused by solid fuelled fire places are investigated. 4 drawings, 13 tables.

4230 Marine Engineering

REFER ALSO TO CITATION(S) 24520

4240 Pollution Control Equipment

REFER ALSO TO CITATION(S) 24780, 25498, 25500

25507 (CONF-8309248—, pp 229-242) **Technologies for reducing pollutant emissions from industrial plants, and implementation of said technologies.** Rentz, O. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. (In German). NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

After an outline of the fundamentals of emission reduction in industrial plants, a status report is given on dust, SO/sub 2/ and NO/sub x/ reduction measures and technologies. Achievable limiting values are presented, and the cost of emission reduction measures is estimated. Pollutant separation systems and political strategies for implementing emission reduction measures are gone into.

4250 Power Cycles

25508 (NP—7751732, pp 1-134) **Technology and cost of thermal power plants with fluidized-bed combustion and with supercharged steam generator. Technical basic concept of thermal power plants with supercharged fluidized-bed combustion with a maximum output efficiency of 105 MJ/s.** 1982. (In German). NTIS (US Sales Only), PC A13/MF A01. File Number DE87751732.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.1. Energy supply.

In the framework of comparative investigations on the use of gas, electricity and district heat in the Rhine and Neckar region, a first contribution dealing with energy supply reports on the technique and cost of thermal power plants with fluidized bed combustion and turbo steam generator. The explanations start from the stritker environmental injunctions as to additional emissions from power and heat cogeneration units. Use of the fluidized-bed technique in combustion engineering contributes essentially to the limiting values for emissions being observed. Sketches showing the mechanism of action convey structural, functional, and performance characteristics of fluidized bed combustion and its components (steam generator, dust filter, compressor, condenser cleaning system, desalination plant, electrical equipment) and indicate advantages of the process. This includes a high heat transition, low combustion temperature, binding of SO/sub 2/ in ash, and low hydrocarbon content in the fluidized bed. Furthermore basic data for planning are indicated, the control technology is described, and hints are given regarding emissions, investment cost and possibilities of adjusting performance to a different level of heat requirement. (HWJ).

25509 (NP—7751732, pp 1-24) **Economic assessment of multistage water heating systems using heat from different types of power plants.** 1982. (In German). NTIS (US Sales Only), PC A13/MF A01. File Number DE87751732.

In Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.1. Energy supply.

A third contribution in the comparative study of the use of gas, electricity and district heat in the Rhine and Neckar region makes a comparison between multi-stage water heating systems, extracting the heat from the different power plant types. The report deals with investigations in extraction of heat from a small thermal power plant with back-pressure steam turbine and fluidized-bed steam generator (heating capacity 70 MJ/s), from a black-coal-fired condensation power plant (heating capacity 400 MJ/s) and from an LWR-type nuclear power plant (1,700 MJ/s). It carries through thermodynamic analyses of these variants as well as thermodynamic calculations. Furthermore the heat circuiting diagrams were laid down, investment cost and net capacities established and comparisons of economic efficiency made. Finally the flow temperatures (90 to 110/sup 0/C) and number of heating stages (3-4) were grouped together in tables for the three power plant types. The economic efficiency figures obtained prove that these power plant types do justify a higher number of heating stages than current two-phase heating. (HWJ).

25510 (NP—7751732) **Investigation on alternative energy sources to be used instead of heating oil (supply concept) in the Rhine and Neckar region. Section A.4: Comparative evaluation of the use of the alternative energy sources, gas, electricity, district heat, by means of studies, practical investigations, and publications. Subsection A.4.1. Energy supply.** (Energie- und Wasserwerks Rhein-Neckar A.G., Mannheim (Germany, F.R.)). 1982. 297p. (In German). NTIS (US Sales Only), PC A13/MF A01. File Number DE87751732.

Subsection A.4.1 'Energy supply' of research project ET 5286 A comprises three chapters: 1) Technology and cost of thermal power plants with fluidized-bed combustion and with supercharged steam generator; 2) Alternative fluidized-bed furnaces for a coal-fueled heat-and-power plant; 3) Economic assessment of multistage water heating systems using heat from different types of power plants. Separate records are available for each of the three chapters. (HWJ).

25511 (ORNL/TM—10351) **Analysis of a mechanically simple external combustion engine with an unusual cycle.** Chen, N.C.J.; West, C.D. (Oak Ridge National Lab., TN (USA)). Mar 1987. 30p. NTIS, PC A03/MF A01. File Number DE87007788.

A single-cylinder, single-piston heat engine with no valves is described. Heat is supplied from an external source, so that a wide variety of heat sources or fuels could be used. The ideal performance of the thermodynamic cycle is calculated; a reasonable power output and indicated efficiency appears to be attainable from a machine of practicable size, operating under very modest conditions of temperature and pressure. 4 refs., 5 figs., 7 tabs.

25512 (SERI/CP—252-2714, pp 149-155) **Intrinsically irreversible acoustic heat engines.** Swift, G.W.; Migliori, A.; Hofler, T.; Wheatley, J.C. (Los Alamos National Lab., NM). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

In a demonstration of an intrinsically irreversible acoustic heat engine, a tube containing a stack of plates is heated at one end and cooled at the other, producing sound at the lowest resonant frequency of the tube. The engine works because the air in the stack of plates is mostly about a thermal penetration depth from the nearest plate, so that the acoustic motion of the air causes it to experience temperature oscillations that are phased with respect to the acoustic pressure oscillations in such a way that net work is done by the air. Such engines are intrinsically irreversible because the necessary phasing is caused by the rather poor thermal contact between the plate and the gas a thermal penetration depth away. Not only prime movers but also heat pumps and refrigerators can be designed. The current understanding of these phenomena is summarized.

25513 (SERI/CP—252-2714, pp 157-166) **Thermodynamics of heat engines in finite time.** Salamon, P. (San Diego State Univ., CA). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

A search for in-principle limitations imposed on the operation of heat engines by the constraint of operation in finite time is described. The subject of thermodynamics was based on similar searches using idealized heat engines. For real operation, one would like a decomposition of a process into its reversible, intrinsically irreversible, and waste components. While it is tempting to include all the known kinds of irreversibilities in attempting this task, results are difficult to obtain and interpret. Furthermore such results lack the generality which characterizes the classical work. One avenue of approach has succeeded, however, in moving onto a plane of generality which vies with classical results. While its roots are once again in heat engines, this approach can now be applied to virtually any process and promises to change their understanding of the energetics of physico-chemical phenomena. The approach is described.

25514 (SERI/CP—252-2714, pp 167-180) **Electrothermodynamic equations of a charged aerosol generator.** Marks, A. (Advanced Research Development, Inc., Athol, MA). Aug 1986. NTIS, PC A12/MF A01. File Number DE86014506. (CONF-8502145—).

From Workshop on solar applications of energy conversion technology; Golden, CO, USA (19 Feb 1985).

An electrothermodynamic (ETD) generator and a compressor are described for use in a Marks/Ericsson Cycle. New equations are derived based on varying the electric charge distribution along the flow axis and new principles based thereon are used in the generator design.

43 PARTICLE ACCELERATORS

4301 Design, Development, And Operation

REFER ALSO TO CITATION(S) 25464, 25477, 26334

25515 (BNL—39263) **BNL upgrade plans.** Foelsche, H.W.J. (Brookhaven National Lab., Upton, NY (USA)). 1987. Contract AC02-76CH00016. 15p. (CONF-870260—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006456.

From International workshop hadron facility technology; Santa Fe, NM, USA (2 Feb 1987).

Brookhaven National Laboratory is proposing two major upgrade projects for a future experimental program with protons and heavy ions. The first is the construction of a Relativistic Heavy Ion Collider (RHIC) which will use the AGS complex as an injector. The second initiative is an upgrade of the AGS proton intensity and duty cycle. Both objectives require a Booster for the AGS which has recently been approved as a construction project. With the completion of the booster, and with certain modifications of the AGS, the facility will ultimately become capable of supporting average proton currents on the order of 25 to 50 microamperes. The RHIC will provide center-of-mass collision energies of 2 x 100 to 125 GeV/amu for ions up to the heaviest masses, and 2 x 250 GeV for protons.

25516 (BNL—39325) **Studies of induced radioactivity at the AGS.** Brown, K.A.; Tanaka, M. (Brookhaven National Lab., Upton, NY (USA)). 1987. Contract AC02-76CH00016. 8p. (CONF-870302—13). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006906.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

With the goals of higher proton intensities, along with the many modes the AGS now runs and those being commissioned to run, we have begun detailed studies of the beam induced radioactivity in the AGS.

25517 (SAND—86-1998C) **RADLAC II accelerator beam experiments.** Mazarakis, M.G.; Leifeste, G.T.; Clark, R.S.; Frost, C.A.; Hasti, D.E.; Johnson, D.L.; Miller, R.B.; Poukey, J.W.; Prestwich, K.R.; Shope, S.L. (Sandia National Labs., Albuquerque, NM (USA)). 19 Mar 1987. Contract AC04-76DP00789. 4p. (CONF-870302—10). NTIS MF A01; 2; GPO Dep. File Number DE87006700.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

A pulsed transmission line linear accelerator, RADLAC-II, composed of an injector plus six post-accelerating gaps was built and successfully operated. A 3 to 4 MV foilless diode injector was used and an annular 30 to 40 kA. Relativistic electron beam was produced and further accelerated through the post-accelerating gaps. The final beam energy was close to the sum of injector and gap voltages and equal to ~16 MeV. The pulsed power drivers, the accelerator, and the beam transport system are described. Experimental results are presented and discussed.

25518 (SAND—86-1999C) **Mechanical and magnetic alignment techniques for the RADLAC-II linear accelerator.** Armistead, D.J.; Bolton, D.L.; Mazarakis, M.G.; Peredo, R. (Sandia National Labs., Albuquerque, NM (USA); Air Force Weapons Lab., Kirtland AFB, NM (USA)). 1987. Contract AC04-76DP00789. 4p. (CONF-870302—12). NTIS MF A01; 2; GPO Dep. File Number DE87006697.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

The RADLAC-II beam line, which includes nine accelerating cavities, 25 solenoidal magnets, and a nine-cryopump vacuum system, is suspended from the top of a water tank by 60, 0.5 cm-diameter, stainless steel rods. There are seven swiveling joints providing beam line flexibility (similar to that of a spinal cord). We have developed a technique to mechanically align the ~12-meter-long accelerator vacuum pipe to within a fraction of a millimeter. A high accuracy microprocessor-equipped theodolite is being used with a television camera, monitor, and hard copier for observation ease, comparison, and documentation. Three illuminated lucite targets with cross hairs are utilized to align the beam line which comprises vacuum pipes of three different I.D.s. For the in-situ magnetic alignment of the solenoids, a new technique is currently being developed and will be presented.

25519 (SAND—86-2148C) **Recirculating electron beam linac.** Tucker, W.K.; Shope, S.L.; Hasti, D.E. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 4p. (CONF-870302—9). NTIS MF A01; 2; GPO Dep. File Number DE87006699.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

One method to achieve a high gradient, linear induction accelerator is to recirculate the electron beam in phase with a repeating accelerating voltage. A two-cavity recirculating accelerator has been designed and operated in a single-pass mode. The prototype accelerator uses a 2.0-MV, 10-kA, 25-ns duration injector and an accelerating cavity that will produce a total accelerating voltage of 5.3 MV for four passes. The design of this machine involved key areas of development in pulsed power, specifically, low-jitter spark gaps and vacuum-liquid interfaces for bipolar electric fields. The recirculation technique under investigation employs an ion focus regime (IFR) electrostatic channel created by a magnetically guided, 300-V, 800-mA electron beam in low pressure (0.10 mTorr) Argon gas. This paper will discuss the recirculation concept, machine design parameters and scaling relationships, and summarize the pulsed power issues.

25520 (SLAC—303, pp 328-329) **Heavy-ion RFQ accelerator MAXILAC achieves 45 keV/AMU.** Mueller, R.W.; Bolle, J.; Keller, R.; Kopf, U.; Liesem, H.; Spaedtke, P.; Schoenlein, A. (GSI, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

In 1985, the heavy-ion RFQ accelerator MAXILAC, designed for the acceleration of ions of A/q up to 130 has been completed 3 modules (May 1985, 20 keV/amu) and, finally, 5 modules (October 1985, 45 keV/amu). The completion was made stepwise because there is no beam diagnostics inside the structure indicating beam losses; if the transmission would be poor, it would have been impossible to see where the beam was lost. The operation of the accelerator is described.

25521 (SLAC—303, pp 333-335) **Use of the IBM-PC computer in accelerator design calculations.** Colman, J. (Brookhaven National Lab., Upton, NY). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

For many reasons it is desirable to develop a stand-alone means of carrying out preliminary calculations in the various accelerator design fields. Work is in progress to allow the use of modified or subset versions of several well-known and widely used codes on the IBM-PC. Codes in preliminary operation include TRANSPORT, for beam-line design; the SUPERFISH code series, for cavity design; and RAYTRACE, for magnets. These codes are surpassing expectations in capabilities, speed of execution, and accuracy.

25522 (SLAC—303, pp 355-357) **Ion acceleration in the CERN Linac 1.** Haseroth, H.; Hill, C.; Tetu, P.; Weiss, M.; Wolf, B.H.; Leible, K.; Spaetke, P.; Klabunde, J.; Langenbeck, B.; Angert, N. (CERN, Geneva, Switzerland). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Ion acceleration at CERN already has a long history but had been limited in the past to deuterons and alpha-particles apart from the usual proton (or H^-) beams. A review on these activities is given. Over the last years the possibilities were discussed to accelerate even heavier ions and detailed plans were worked out for an oxygen injector for Linac 1 by a GSI-LBL-CERN collaboration. The scheme, including the combination of two injectors which allow independent injection of protons, H^- or oxygen ions using two radio-frequency quadrupoles, is discussed. The progress concerning oxygen ion acceleration is presented together with first results.

25523 (SLAC—303, pp 361-363) **Heavy ion RFQ with high accelerating gradient.** Chidley, B.G.; Hutcheon, R.M.; McMichael, G.E. (Atomic Energy of Canada Ltd., Chalk River, Ontario). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

An RFQ accelerator that will accelerate ions of mass 6 to 60 amu with 1 keV/amu input energy to an output energy of 60 keV/amu has been proposed as part of an ISOL facility at TRIUMF. This RFQ has some novel features, including single turn lumped inductors, modular construction, and an aperture increase and longitudinal voltage tilt of 2.5 between input and output. Continuously increasing the aperture and intervane voltage of an RFQ as the particle velocity increases can significantly reduce its length while avoiding the complications of multiple tanks with step changes between them. Beam dynamics calculations showing the advantages and disadvantages of such tapered RFQ's are presented. From structure considerations, a 4-rod RFQ with the desired bore and voltage tilt seems inexpensive to build. A 1/5 scale cold model of the proposed TRIUMF RFQ was built, and preliminary measurements compared with computer code predictions.

25524 (SLAC—303, pp 364-366) **Ionization front accelerator.** Olson, C.L. (Sandia National Labs., Albuquerque, NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC04-76DP00789.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The ionization front accelerator (IFA) is the first controlled collective accelerator powered by an intense relativistic electron beam to demonstrate particle acceleration with a high acceleration gradient. The IFA concept is reviewed, results of second generation accelerator experiments are summarized, and an analysis for future IFA development is presented.

25525 (SLAC—303, pp 367-370) **KUTI-20 accelerator first stage adjusting.** Dolbilov, V.G.; Mironov, V.I.; Fateev, A.A.; Sumbaev, A.P.; Petrov, V.A.; Sidorov, A.I.; Kazacha, V.I.; Sarantsev, V.P.; Tiutiunnikov, S.I.; Shcheulin, A.S. (Joint Institute for Nuclear Research, Dubna, USSR). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The KUTI-20 is a collective heavy ion accelerator being constructed in Dubna. Today the adjustment of the first stage of the accelerator are finished. First results of its adjustment are given.

25526 (SLAC—303, pp 377-379) **Construction and acceleration characteristics of the Tokyo Institute of Technology heavy ion linac.** Hattori, T.; Sato, K.; Suzuki, H.; Ogari, Y.; Arai, E. (Tokyo Institute of Technology, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A heavy ion accelerator system has been constructed for material sciences and nuclear physics studies. It consists of a tandem Pelletron as an injector and two heavy-ion linacs. The first module of the linac systems was designed to accelerate particles injected at 240 keV/u with charge to mass ratio (q/A) of 1 - 1/4 up to 2.4 Me/u. The accelerating cavity has an interdigital H structure. The accelerating resonance frequency is 48 MHz. The linac has successfully accelerated ion beams of H, C, O, Cl. The overall transmission coefficient has been determined to be 30 - 40% for a dc proton beam. The effective shunt impedance (Ze) has been determined to be about 180 M Omega/m by the experiment. This Ze is about 5 times as large as Ze of other accelerating structures in the same velocity region.

25527 (SLAC—303, pp 385-390) **Two-beam accelerator.** Sessler, A.M.; Hopkins, D.B. (Lawrence Berkeley Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC03-76SF00098.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The Two-Beam Accelerator (TBA) consists of a long high-gradient accelerator (HGS) adjacent to an equal-length Free Electron Laser (FEL). In the FEL, a beam propagates through a long series of undulators. At regular intervals, waveguides couple microwave power out of the FEL into the HGS. To replenish energy given up by the FEL beam to the microwave field, induction accelerator units are placed periodically along the length of the FEL. In this manner it is expected to achieve gradients of more than 250 MV/m and thus have a serious option for a 1 TeV x 1 TeV linear collider. The state of present theoretical understanding of the TBA is presented with particular emphasis upon operation of the steady-state FEL, phase and amplitude control of the rf wave, and suppression of sideband instabilities. Experimental work has focused upon the development of a suitable HGS and the testing of this structure using the Electron Laser Facility (ELF). Description is given of a first test at ELF with a seven-cell $2\pi/3$ mode structure which without preconditioning and with a not-very-good vacuum nevertheless at 35 GHz yielded an average accelerating gradient of 180 MV/m.

25528 (SLAC—303, pp 391-397) **Progress on plasma accelerators.** Chen, P. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Several plasma accelerator concepts are reviewed, with emphasis on the Plasma Beat Wave Accelerator (PBWA) and the Plasma Wake Field Accelerator (PWFA). Various accelerator physics issues regarding these schemes are discussed, and numerical examples on laboratory scale experiments are given. The efficiency of plasma accelerators is then revealed with suggestions on improvements. Sources that cause emittance growth are discussed briefly.

25529 (SLAC—303, pp 398-404) **Wake field acceleration.** Bialowons, W.; Bremer, H.D.; Decker, F.J.; Hartrott, M.V.; Lewin, H.C.; Voss, G.A.; Weiland, T.; Wihelm, P.; Chengde, X.; Yokoya, K. (Deutsches Elektronen-Synchrotron DESY, Hamburg, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The possibility of accelerating particles with high gradients in a Wake Field Transformer is discussed. The progress of this experiment is described. The development of the high current hollow beam electron gun was continued. In the conventional linac, the hollow beam was accelerated to about 6 MeV. Beam monitors, two gap monitors, two fluorescent monitors, and a Cherenkov monitor were in operation. Calculations with the computer code WAKTRACK gave the final details for the high-energy section of the accelerator that will be installed during 1986.

25530 (SLAC—303, pp 421-426) **Intense low emittance linac beams for free electron lasers.** Smith, T.I. (Stanford Univ., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

New approaches to linear accelerator design are necessary in order to produce the intense low emittance beams required for free electron laser operation. Examples are the use of the high gradient single cell or dual cell resonators instead of conventional multicavity structures, the use of multiple frequency (harmonically related) rf fields for acceleration instead of single frequency fields, and the use of magnetic bunching at relatively high energies instead of conventional bunching at low energy. Advantages of the use of multiple frequency rf fields are discussed, and the results of numerical calculations comparing multiple frequency vs. single frequency acceleration are presented.

25531 (SLAC—303, pp 429-430) **Pulse compression system for the ANL 20 MeV linac.** Mavrogenes, G.; Norem, J.; Simpson, J. (Argonne National Lab., IL). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract W-31-109-ENG-38.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The pulse compression system using built on the Argonne 20 MeV electron linacs is described. The system is designed to rotate the bunch from the present measured pulse length of 38 psec FWHM, to pulse lengths of 5 to 6 ps with the large instantaneous currents (1-4 kA) possible instantaneous currents. This system was necessary to extend the study of reactive fragments of molecules to the time scale of a few picoseconds, in particular to examine the chemistry of electrons and ions before and during relaxation of the surrounding media. These experiments are not sensitive to the beam energy spread. High Energy Physics experiments studying wake fields have also been proposed using the short bunches and the facility was designed so that the wake field experiment could share the beam bunching system. The 20 MeV electron linac uses a double gap, 12th subharmonic prebuncher together with a one wavelength 1.3 Ghs prebuncher to produce a single pulse of 38 ps from one occupied rf bucket. Beam emittances of 15.7 mmmr have been measured for 40 nC of accelerated charge and 8 mmmr at 10 nC. The energy spread of dE/E - 1% (FWHM) has been measured at 40 nC. Thus the accelerated beam has excellent time structure, high current, and good emittance.

25532 (SLAC—303, pp 431-433) **Positron injection linac system for the Argonne Light Source.** Mavrogenes, G.; Cho, Y.; Khoe, T. (Argonne National Lab., IL). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract W-31-109-ENG-38.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The Argonne 6 GeV Light Source will use positrons rather than electrons in order to avoid ion trapping of the residual gas. One of the primary requirements of the linac system is the capability to deliver relatively intense short bunches of positrons in the stationary buckets of the booster synchrotron without utilizing a positron accumulator ring. A linac system for accomplishing this task is described. It consists of a 200-MeV, high-current, electron linac and a 450-MeV positron linear accelerator with a DESY-type converter in between. The first accelerating section of the electron linac is a high field standing wave structure. The rest of the accelerating sections for both the electron and positron linacs are conventional disk-loaded T.W. guides using the SLAC-SLED pulse compression scheme.

25533 (SLAC—303, pp 434-436) **Progress report on ANL advanced accelerator test facility.** Konecny, R.; MacLachlan, J.; Norem, J.; Ruggiero, A.G.; Schoessow, P.; Simpson, J. (Argonne National Lab., IL). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract W-31-109-ENG-38.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Argonne National Laboratory is constructing a facility for use in a program to experimentally study a variety of advanced acceleration mechanisms. Many new methods of particle acceleration have been proposed in recognition of the requirements for the next generation of colliders. Some of these ideas are well enough developed to warrant experimental studies. There are several active programs at various laboratories directed toward specific methods, such as FEL rf sources, plasma beat wave, and switched power linacs. The facility at Argonne is particularly well suited for use in the study of wake field acceleration in a variety of structures and media. Recognition that Argonne was in a unique position to address this study developed as a result of several years experience using a 20 MeV, short pulse electron linac operated by the Chemistry Division. Following a several month period of planning, construction of the facility began in the summer of 1985. At a glance the design may appear quite simple, but many simultaneous constraints complicated the design considerably. The final design contains a number of subtle yet important features are described. Initial experiments will include wake field measurements using both structures and plasmas. These experiments are described in detail.

25534 (SLAC—303, pp 455-457) **X-band coaxial standing-wave linear accelerator structure.** Tanabe, E.; Bayer, M.; Ireton, S.D.; Kalkanis, G. (Varian Associates, Inc., Palo Alto, cA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A new high efficiency X-Band, standing-wave linear accelerator cavity structure has been developed. It utilizes a shaped coaxial cavity as the coupling cavity between accelerating cavities for $\pi/2$ mode operation, hence the overall diameter is extremely small while maintaining a very high shunt impedance. The coupling cavity and accelerating cavity are easily machined on opposite sides of a single cell, eliminating any subassembly steps. Cavity geometries were developed using the computer codes LACC & LALA. Prototype 1.5 MeV and 4.0 MeV, 20 cm long accelerators are now under development. The accelerators employ a stepped field focusing technique to keep the beam focused at low field levels. The beam dynamics code PARMELA was used to optimize the longitudinal bunching and transverse beam characteristics. The accelerator design parameters, as well as experimental results, are presented.

25535 (SLAC—303, pp 493-495) **Radiation of a charge in a perfectly conducting cylindrical pipe with a jump in its cross section.** Kheifets, S.A.; Heifets, S.A. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The problem of finding the electromagnetic fields created by a charge moving through various geometric structures bounded by metallic walls has an important bearing on the accelerator theory. Apart from evident need for reliable evaluation of the energy loss into higher modes, there is also an important problem of evaluating the coupling impedance due to changes in the particle environment. While for a long bunch (in comparison to the relevant dimensions of the considered structure) there are several reliable numerical codes which do the job, they rapidly become too time consuming for short bunches. The results of calculations of electromagnetic fields radiated by a point charge moving on an axis of a cylindrical superconducting pipe with an abrupt change in its cross section are presented.

25536 (SLAC—303, pp 505-507) **90 MeV electron linac of IHEP.** Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A 90 Mev electron linac has been built at the Institute of High Energy Physics as a prototype of the injector of BEPC (Beijing Electron Positron Collider). This accelerator consists of a high current electron gun, prebuncher, buncher, one 3 meter accelerating section is pre-injecter and two sections more for further acceleration. The first beam was obtained in early 1985, and after tune-up, its performance has met the design specifications: energy, 90 Mev; pulse current, 500 mA; energy spread, 1%; RF pulse width, 3 μs; beam pulse width, 2.5/20 ns; energy multiplication factor of the SLED type pulse compression scheme, 1.4.

25537 (SLAC—303, pp 512-514) **Superconducting 130 MeV recyclotron for electrons at Darmstadt.** Alrutz-Ziemssen, K.; Graef, H.D.; Huck, V.; Hummel, K.D.; Kaster, G.; Knirsch, M.; Richter, A.; Schanz, M.; Simrock, S.; Spamer, E.; Titze, O. (Institut fuer Kernphysik, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The basic design and the present status of construction of a 130 MeV superconducting CW electron accelerator is described. The accelerator contains 11 multicell accelerating structures fabricated of Nb-metal and is operated at a temperature of 2K. The quality factor $Q \approx 3 \times 10^9$ and the average energy gain of each structure is 5 MeV/m. At present the 250 keV injection beam line, the 10 MeV injector, the first beam bend into the main accelerator and the first recirculation beamline for injecting the electron beam a second time into the main accelerator are completed. First rf tests of 3 coupled superconducting structures in the injector have been performed. The present status of the whole project as well as the experience from the first test are reported.

25538 (SLAC—303, pp 515-517) **200 MeV linac at HESYRL.** De-fa, W.; Yuan-ji, P.; To-hui, H. (Univ. of Science and Technology of China, Hefei). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A 200 MeV LINAC is being built at the Hefei National Synchrotron Radiation Laboratory, China. The LINAC is mainly as an injector for the 800 MeV electron storage ring, which is to be a facility dedicated to synchrotron radiation use. To make full use of the LINAC beams for other research and application use are provided. The beam current at the exit of the LINAC is supposed to be 50-100 mA in 2-4 ns or 0.2-1 μs pulses variable according to what is needed. It is expected that the LINAC will be put in service in 1987.

25539 (SLAC—303, pp 518-519) **New electron linac for the Saclay stretcher ring project.** Aune, B.; Bourat, C.; Djidi, K.; Jablonka, M.; Juillard, M.; Hetter, F. (CEN Saclay, Gif-sur-Yvette, France). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The ALS-II project is an electron accelerator designed for a maximum energy of 1.7 GeV and nearly 100% duty cycle. It consists in a low duty factor linac injecting a pulse stretcher ring. The existing linac (0.6 GeV, 1 % duty cycle) has to be transformed in keeping the same accelerating sections. It will use 23 new klystrons (25 MW, 25 KW, efficiency ≃ 60%) now under development by Thomson-CSF. In addition, the beam will be bunched at 600 MHz ($f_0/5$), to match the RF frequency of the ring. A subharmonic prebunching system, including a 600 MHz chopper is described.

25540 (SLAC—303, pp 546-548) **EG & G electron linac modifications.** Norris, N.J.; Detch, J.L.; Kocimski, S.M.; Sawyer, C.R.; Hudson, C.L. (EG & G Energy Measurements, Inc., Golena, CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC08-83NV10282.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The electron linear accelerator at EG & G/EM, Santa Barbara Operations, installed in 1963, has been subsequently modified to produce short, intense beam pulses used in the test, calibration and development of many types of fast radiation detectors and systems. The first practical use of the single RF pulse operation, now used in many accelerators, was demonstrated on this accelerator in the late 60s. A major three-year modification, to replace obsolete equipment and bring all the subsystems up to the current state of the art, has increased the beam intensity, stability and reliability. These modifications are discussed.

25541 (SLAC—303, pp 549-552) **Acceleration of electrons by the wake field of proton bunches.** Ruggiero, A.G. (Argonne National Lab., IL). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract W-31-109-ENG-38.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Details are presented of a novel idea to accelerate low-intensity bunches of electrons (or positrons) by the wake field of intense proton bunches travelling along the axis of a cylindrical rf structure. Accelerating gradients in excess of 100 MeV/m and large transformer ratios, which allow for acceleration of electrons to energies in the TeV range, are calculated. A possible application of the method is an electron-positron linear collider with luminosity of 10^{33} cm^{-2} s^{-1}. The relatively low cost and power consumption of the method is emphasized.

25542 (SLAC—303, pp 553-556) **First observations of acceleration of injected electrons in a laser plasma beatwave experiment.** Ebrahim, N.A.; Martin, F.; Bordeur, P.; Heighway, E.A.; Matte, J.P.; Pepin, H.; Lavigne, P. (INRS-Energie, Varennes, Quebec). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The first experimental observations of acceleration of injected electrons in a laser driven plasma beatwave are presented. The plasma waves were excited in an ionized gas jet, using a short pulse high intensity CO_2 laser with two collinearly propagating beams (at $\lambda = 9.6$ μm and 10.6 μm) to excite a fast wave (v/sub p/ = c). The source of electrons was a laser plasma produced on an aluminum slab target by a third, synchronized CO_2 laser beam. A double-focusing dipole magnet was used to energy select and inject electrons into the beatwave, and a second magnetic spectrograph was used to analyze the accelerated electrons. Electron acceleration was only observed when the appropriate resonant plasma density was produced ($\sim 10^{17}$ cm^{-3}), the two laser lines were incident on the plasma, and electrons were injected into this plasma from an external source.

25543 (SLAC—303, pp 557-559) **Recirculating linac as an injector for small storage rings or free electron lasers.** Gillespie, W.A.; Hughes, E.A.; Marks, N.; Saxon, G. (Dundee College of Technology, Scotland). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

There is an increasing interest in the use of small storage rings to produce synchrotron radiation for such purposes as lithography. Clearly, such rings need injectors and the provision of these can add significantly to the overall cost of a storage ring project in terms of both hardware and space requirements. There is a need, therefore, to consider the most cost-effective way of providing for injection. It is suggested that the recirculating linac (or double-sided microtron) design meets this aim at least for injection energies up to about 450 MeV and maybe higher. The concept on which the proposal is based was first given by Kaiser, who called it a bicyclotron. The concept is described.

25544 (SLAC—303, pp 560-562) **Modifying a research lining laboratory into an applied radiation facility.** Block, R.C. (Rensselaer Polytechnic Institute, Troy, NY). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

What does one do with a powerful accelerator that has performed well for a quarter of a century and is still in excellent condition? At Rensselaer in the Department of Nuclear Engineering the authors have such an accelerator: a 9-section travelling wave L-band linac with maximum energy of 100-MeV and maximum (average) beam power of over 40 KW. In response to the decreasing funding of neutron physics research, for which the laboratory was established, they have modified the accelerator to provide intense ionizing radiation fields for such diverse applications as coloring topazes, measuring transient radiation effects in advanced semi-conductor devices, simulating radiation levels in commercial-size reactors, etc., while at the same time maintaining the capability to carry out neutron physics research. Radiation fields of over 1.0E+11 rad/sec and integrated doses in the Gigarads range are now routinely available.

25545 (SLAC—303, pp 563-565) **Operation of a 300 MeV electron linac in the short-beam mode.** Azhippo, V.A.; Ajzatskij, N.I.; Batij, V.G.; Bozhko, V.P.; Golovnya, V.Ya.; Dyukov, S.N.; Ivanov, G.M.; Makhnenko, L.A.; Ryabka, P.M.; Olejnik, S.N.; Timoshevskij, G.F. (Kharkov Institute of Physics and Technology, USSR). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The 300 MeV electron linac was operated in conjunction with a versatile injector complex in the short (ns) beam mode. The operating conditions permitted a pulse neutron source and spectrometer to be employed in the time-of-flight measurements of neutron spectra.

25546 (SLAC—303, pp 566-569) **Self-oscillatory mode of acceleration in electron linac with feedback.** Azhipp, V.A.; Ajzatskij, N.I.; Makhnenko, L.A. (Kharkov Institute of Physics and Technology, USSR). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The self-oscillatory mode of acceleration was studied both theoretically and experimentally with a versatile injector complex installed on a 300 MeV electron linac. It is shown that using feedback in linacs it is possible to produce modulated relativistic beams.

25547 (SLAC—303, pp 570-572) **Feedback system analysis for beam breakup in a multipass multisection electron linac.** Mosnier, A.; Aune, B. (CEN Saclay, Gif-sur-Yvette, France). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A recirculating electron accelerator based upon superconducting cavities technology is envisaged in different laboratories to produce a high duty cycle beam with energy in the GeV region. In all the cases the design current is in the 100 μA range. Beam break up is a severe limitation in this kind of accelerator due to the positive feedback of the returning beams. Therefore, a careful analysis of the phenomenon must be made to determine the permissible characteristics of the superconducting cavities. Different analysis have been made for recirculating beam breakup by Volodin, Herminghaus, Vetter, Lyneis, and others. An analysis is presented based upon feedback system theory which takes into account the different cavities of the linac, the optics of the linac and of the recirculating path. The frequencies of the cavities may be the same or distributed in a random way. A computer program was written which computes the threshold current for a given configuration. The result can be checked with a simulation code which computes the transverse motion of the bunches based upon wake fields equations. An example is given for the Saclay proposal of a 2 GeV accelerator consisting of 4 passes in a 500 MeV, 100 m-long superconducting linac.

25548 (SLAC—303, pp 573-575) **Studies of electron linac beam postacceleration in a chain of passive cavity structures.** Fursov, G.L.; Kushnir, V.A.; Romas'ko, V.P.; Shenderovich, A.M.; Vishnyakov, V.A.; Zakutin, V.V. (Kharkov Institute of Physics and Technology, USSR). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Traditionally, the energy of electron linacs can be raised by increasing the number of accelerating sections and their RF power supply systems, which is rather laborious and costly procedure. Therefore, it is important to search for simpler and more effective methods of increasing the energy of the existing accelerators. One way of accomplishing this resides in further perfection of accelerating structures and their RF sources. The potentialities of these methods are restricted by electrical breakdown of RF linac components. Another way is connected with energy exchange between the beam particles during the pulse in passive structures. The experimental studies of this method are discussed.

25549 (SLAC—303, pp 576-577) **Kharkov electron linac as injector for stretcher ring.** Vishnyakov, V.A.; Dovbnya, A.N.; Demyanenko, G.K.; Kobezsky, V.M.; Mufel, V.B.; Pugachev, G.D.; Shendrik, V.A. (Institute of Physics and Technology, Kharkov, USSR). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The reconstruction design of the Kharkov linac is discussed. The planned reconstruction envisages a serious upgrading of the linac principal features and construction of stretcher ring at the linac end-line to achieve higher duty cycle, continuous CW operation of the accelerator. The base line characteristics of the linac and its future beam parameters are described.

25550 (SLAC—303, pp 578-579) **Few aspects of excitation of wake waves in accelerating structures.** Laziev, E.M.; Tsakanov, V.M. (Yerevan Physics Institute, Armenia, USSR). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The possibilities of wake-wave acceleration are discussed. In the present work some aspects of excitation of wake waves in accelerating structures are considered. For simplicity, a waveguide with dielectric filling is taken as an accelerating structure, which allows one to obtain analytical expressions for the radiated fields, avoiding numerous computations in the case with diaphragmetic waveguides.

25551 (SLAC—303, pp 585-590) **Future e^+ e^- linear colliders and beam-beam effects.** Wilson, P.B. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

As designers of the high energy accelerators of the future, the first question asked is, What do the particle physicists want? It is a fundamental fact of nature that the cross sections for the production of interesting events in electron-positron collisions in the TeV energy range tend to fall-off inversely as the square of the particle energy. The luminosity for two colliding beams, either in a storage ring or from a linear collider, is defined as the event rate divided by the cross section. In order to keep the event rate at an acceptable level, the luminosity must, therefore, increase approximately as the square of the beam energy. The luminosities which follow this scaling are shown for four collider energies. The choice of linac parameters is strongly coupled to various beam-beam effects which take place when the electron and positron bunches collide. These beam-beam effects are summarized and the RF design of a 650 GeV center-of mass collider is discussed.

25552 (SLAC—303, pp 591-596) **Factors limiting the operation of structures under high gradient.** Schriber, S.O. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Factors limiting the operation of rf structures under high-gradient conditions are described. Included are recent rf measurements at laboratories in Europe, Asia, and North America and how these measurements relate to earlier data as exemplified by the use of the Kilpatrick criterion (Kp). Operation limitations will cover mechanical, geometry, thermal, and surface constraints and the associated impact on structure design, fabrication, and material selection. Generally, structures operating continuous wave (110% duty factor) appear to be limited to peak surface fields at about twice the Kilpatrick limit, whereas pulsed structures operating with pulse lengths less than a millisecond can attain peak surface fields five times the Kilpatrick limit.

25553 (SLAC—303, pp 599-603) **Collider constraints in the choices for wavelength and gradient scaling.** Lawson, J.D. (Rutherford Appleton Lab., Chilton, England). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

During the last few years many suggestions have been made for novel accelerating schemes, with the aim of making center of mass energies of 1 TeV and above available for $e^+ e^-$ collisions at an acceptable cost. A wavelength range from microns to centimeters and field gradients from tens to thousands of MeV per meter have been considered. It is now evident that the need for high luminosity with acceptable power cost in the face of destructive collider constraints imposes severe restrictions on the choices available. An attempt is made to examine these in a general way, but with emphasis on wavelength and gradient scaling. Non-harmonic schemes, where an equivalent wavelength must be assigned, are included in the survey, and the use of multiple bunches considered. The need for essentially new inventive suggestions is emphasized.

25554 (SLAC—303, pp 3-7) **History of proton linear accelerators.** Alvarez, L.W. (Lawrence Berkeley Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The development of proton linear accelerators is reviewed. The author's personal involvement in the development of these accelerators is related.

25555 (SLAC—303, pp 10-13) **Linear induction accelerators.** Briggs, R.J. (Lawrence Livermore National Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract W-7405-ENG-48.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The development of linear induction accelerators has been motivated by applications requiring high-pulsed currents of charged particles at voltages exceeding the capability of single-stage, diode-type accelerators and at currents too high for r.f. accelerators. In principle, one can accelerate charged particles to arbitrarily high voltages using a multi-stage induction machine, but the 50-MeV, 10-kA Advanced Test Accelerator (ATA) at LLNL is the highest voltage machine in existence at this time. The advent of magnetic pulse power systems makes sustained operation at high-repetition rates practical, and this capability for high-average power in very likely to open up many new applications of induction machines in the future. The US induction linac technology is surveyed with primary emphasis on electron machines. A simplified description of how induction machines couple energy to the electron beam is given, to illustrate many of the general issues that bound the design space of induction linacs. A key issue in all high-intensity linacs is that of beam instability.

25556 (SLAC—303, pp 22-28) **RF linacs for esoteric applications.** Jameson, R.A. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Particle accelerators of various types have been considered for many years in terms of their application to national defense. Recently, the Strategic Defense Initiative has focused and emphasized such applications. After appropriate and extensive development, accelerators could fulfill important roles in a defensive-system architecture and could compete effectively with other technologies. A great deal of the required development is engineering. Aspects of the R & D program on rf-linac-based applications are discussed, and potential long-term influences on accelerator technology are outlined.

25557 (SLAC—303, pp 29-32) **Rf power sources for 1990 and beyond.** Reid, D.W. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The types of devices and system architectures that show promise in providing rf power sources for future space requirements are discussed. These solutions are extrapolated to accelerators that are now being planned for construction and commissioning in the 1990s and suggests technological advantages of using SDI-developed rf systems. Finally, the present state of the various SDI-sponsored high-powered rf-development programs will be reviewed.

25558 (SLAC—303, pp 33-36) **Linacs for medical and industrial applications.** Hamm, R.W. (AccSys Technology, Inc., Pleasanton, CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Linear accelerators for medical and industrial applications have become an important commercial business. Microwave electron linacs for cancer radiation therapy and high-energy industrial radiography form the bulk of this market, but these, as well as induction linacs, are now being offered for radiation processing applications such as sterilization of disposable medical products, food preservation and material modifications. The radio frequency quadrupole (RFQ) linac has now made the ion linac also practical for commercial applications in medicine and industry, including radiation therapy, isotope production, neutron production, materials modification, and energy transfer processes. Ion linacs for several of these applications will soon be commercially available. The market for both ion and electron linacs is expected to significantly grow in several exciting and important areas.

25559 (SLAC—303, pp 39-42) **Operational experience with SLAC energy upgrade.** Allen, M.A.; Cassel, R.L.; Dean, N.R.; Konrad, G.T.; Koontz, R.F.; Schwarz, H.D.; Vleiks, A.E. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

To produce energies of over 50 GeV for SLC, all klystron stations on the accelerator are being upgraded to produce 250 MeV energy contribution per station. This involved installing new, higher power, longer pulse klystrons, upgrading klystron modulators to provide these higher voltage, longer klystron beam pulses, and a new interlock and protection system. A new VAX based diagnostic system including automated microwave measurements, klystron beam monitors, and modulator performance checks is being implemented. A block diagram of the klystron-modulator system is shown. To date, over half of the new klystrons have been installed and tested, the modulator upgrade program has converted 22 sectors (8 stations each) of modulators out of 30, and a four sector sampling of klystrons has been run at full SLC specs, namely 350 kV beam voltage, 3.5 microsecond pulse duration, peak output power in excess of 60 MW, and PRF of 120 pps. The klystron design, modulator design, interlock and diagnostic systems, and the results of the initial operation are discussed.

25560 (SLAC—303, pp 43-45) **Focusing mechanisms in the Pulselac CU accelerator.** Johnson, D.J.; Lockner, T.R. (Sandia National Labs., Albuquerque, NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC04-76DP00789.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The post-acceleration of a 400 keV, 10 kA proton beam by a 200 kV magnetically insulated gap was investigated. The deflections from self and applied E and B fields were measured and compared to calculated values. It was found that the beam is inadequately space-charge neutralized without gas puffs in regions of applied-B field to allow efficient transport. The beam is also noncurrent neutralized in these regions leading to self-magnetic deflection. The applied-B field was used to focus the beam both directly as a solenoidal lens and indirectly by defining the equipotential surfaces in the accelerating gap. It is pointed out how azimuthal asymmetries in the beam current density and cathode plasma cause beam self-field asymmetries that lead to emittance growth.

25561 (SLAC—303, pp 90-92) **Boiling heat transfer process in the design of high power linac structures.** Ngoc, T.T.; Labrie, J.P. (Atomic Energy of Canada Ltd., Chalk River, Ontario). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The heat removal efficiency of the boiling heat transfer process is very high. This process has been applied in the design of a high power 1350 MHz on-axis coupled structure. The operating limits of such a design and its advantages compared to a more conventional scheme with single phase flow forced convection are discussed.

25562 (SLAC—303, pp 93-95) **New design of profile grid electronics with high performance.** Fradj, M.; Christmann, R.; Hartung, M.; Strehl, P. (GSI, Gesellschaft fur Schwerionenforschung mbH, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

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At the Unilac, beam profiles are measured at about 100 locations by means of profile grids. In order to eliminate the elaborate service for off-set adjustments a new circuit for the processing of pulsed current signals has been designed. Current sensitivity was also improved. The time between current pulses if utilized for automatic drift compensation. For the anticipated time-shared operation of the Unilac and for simultaneous display of several beam profiles, a fast solid state multiplexer has been developed, which is capable of switching currents down to 100 pA with good linearity. The newly designed amplifier circuits including the automatic off-set compensation and the FET-current multiplexer are described. The complete electronics is controlled by a microprocessor which is integrated into the system. A description of the microprocessor board and the software is given as well.

25563 (SLAC—303, pp 96-97) **Fast on-line phase measurement of pulsed RF signals in the range of 9 - 108 MHz.** Losert, W.; Fradj, M.; Christmann, R.; Hartung, M.; Wilms, D.; Strehl, P. (GSI, Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A new fast on-line measurement system was developed for the UNILAC multiple beam operation. The system allows the measurement storage of the digitized phase values of 6 pulsed rf-signals during a time interval of 333 micro-seconds. The rf-signals are grouped into blocks of 6 and measured in a sequential order. At present 6 blocks are connected to the measurement system and therefore, one complete measurement cycle lasts 2 milliseconds. The system can easily be extended to more than 6 blocks. A microprocessor handles the data acquisition, monitoring and synchronization. A touch panel is used as communication interface between operator and phase measurement system. For convenience of trouble shooting the phase detector signals can be viewed on an oscilloscope. A numerical display integrated in the hardware allows to control the electronics without the microprocessor.

25564 (SLAC—303, pp 98-100) **Universal electronic phaseshifter.** Hutter, G.; Gutowski, W.; Waitz, K. (GSI, Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Future time-sharing operation of the UNILAC for low energy experiments and injection into the Synchrotron SIS requires varying the amplitudes and phases of the accelerating structures' rf from pulse to pulse with a 50 Hz repetition rate. Fast variation of the amplitude is already provided, but the phaseshifting is done so far by coaxial relays and trombones. The UNILAC consists of accelerating structures with operating frequencies of 27 MHz and 108 MHz, bunchers at 9 and 27 MHz an choppers down to 1.5 MHz. For a new high current injector, structures with frequencies of 13.5 and 54 MHz are also being considered. A new electronic phaseshifter with a range of +/- 180° should be usable with minimal changes at all these frequencies. The selected principle was a digital phase-locked loop circuit. Besides the necessary speed, the realized circuit has several additional advantages. Phaseshifters at 9, 4.5 and 1.5 MHz have been in operation for one year without problems. A prototype of a 108 MHz phaseshifter is under test.

25565 (SLAC—303, pp 104-105) **Cryogenic studies of rf accelerating structures, vintage 1978.** Liska, D.; Uher, J.; Potter, J. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Cryogenically cooled rf cavity studies were undertaken at Los Alamos in 1978 to test the effectiveness of reduced temperature on the Q-enhancement of 450-MHz drift-tube linac structures. A complete facility was set up to do high power tests, not only at liquid nitrogen (LN_2) temperature but with liquid hydrogen (LH_2) as well. The cavity, Dewar, klystron test stand, and a remote outdoor enclosure were constructed. Hydrogen safety approval for the tests was obtained. Unfortunately, the hydrogen tests were never done. However, the cavity was tested at high power in LN_2 and a Q-enhancement of 2.02 was recorded, compared to 2.7 expected theoretically. This work is now continuing with improved measuring techniques using some of the same apparatus. The early work and its continuation today are discussed.

25566 (SLAC—303, pp 106-108) **High power pulsed klystron for linacs.** Onodera, T.; Iyeki, H.; Hayashi, K. (Mitsubishi Electric Corp., Hyogo, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Three types of klystrons for linacs are currently produced. These are the PV-2012 (7MW/10kW), PV-2014 (25MW/30kW), and PV-3030A (30MW/12kW), for the S-band. Now two types of klystrons for new demands are under development. These are the PV-3030B (30MW/30kW) for the S-band and PV-9002 (2MW/2kW) for the X-band. A explanation of the characteristics improvements of the production tubes are given. The resonant ring test of the output window for PV-3030B and design study of PV-9002 are described.

25567 (SLAC—303, pp 109-111) **Improving the efficiency of microwave devices with a double output cavity.** Eppley, K.R.; Herrmannsfeldt, W.B.; Lee, T.G. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Double output cavities have been used experimentally to increase the efficiency of high-power klystrons. Particle-in-cell simulations with the 2+1/2 dimensional code MASK were used to optimize the design of double output cavities for the lasertron and the 50 MW klystron under development at SLAC. Design considerations for double output cavities (e.g., optimum choice of voltages and phases, efficiency, wall interception, breakdown) are discussed. How once calculates the cavity impedance matrix from the gap voltages and phases is discussed. Simulation results are compared to experience with the 150 MW klystron.

25568 (SLAC—303, pp 116-118) **Construction and first operation of upgraded linear accelerator.** Fukumoto, S.; Igarashi, Z.; Ikegami, K.; Kamei, T.; Kato, T.; Kubota, C.; Machida, S.; Mori, Y.; Shintomi, T.; Takagi, A.; Takasaki, E. (National Lab. for High Energy Physics, Ibaraki-ken, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A new Alvarez linac cavity was built and installed to boost 20 MeV beams to 40 MeV. Protons were replaced by H^- ions for more efficient charge-exchange injection to the synchrotron. As the peak intensity reduced greatly, extensive beam loading compensation is no longer needed and the rf system is modified so that both the old and new cavities are fed by the power amplifiers which excited previously the old 20 MeV cavity. The linac beam is 8 ~ 10 mA, 20 Hz and usually with pulse duration of 20 to 50 μS. Polarized H^- beam of 12 μA with 58% polarization is achieved. The debuncher compresses momentum spread of 0.7% FWHM to a half of it in routine operation.

25569 (SLAC—303, pp 119-121) **Rf tuning of the KEK 40 MeV proton linac with post couplers.** Kato, T.; Machida, S. (National Lab. for High Energy Physics, Ibaraki-ken, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

An Alvarez linac was constructed to increase the output energy from 20 MeV to 40 MeV at KEK. The new tank was stabilized by post couplers and the flatness of the TM010 field distribution was within +/- 0.7 %. Equivalent circuit analysis which numerically solves the loop equations including stem and post currents in addition to tank current corresponding to the accelerating field explains rf characteristics of a post-coupled structure.

25570 (SLAC—303, pp 122-124) **Rf-sources for proton linacs.** Faillon, G.; Tran, D.T. (Thomson-CSF Div. Tubes Electroniques, Boulogne-Billancourt, France). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

In existing proton linacs, the choice of the RF frequency used at the beginning of the accelerator is the result of a difficult compromise between the injection energy (that is, the dimensions of the electrostatic injector), and the diameter of the accelerating structure (chosen in such a way as to allow the first quadrupole lens to be contained in the first drift tube). With few exceptions, the RF frequency used is 200 MHz. At this frequency, triodes can supply a few MW of peak power, but only with a duty cycle of a few percent or less. Klytrons would be able to improve this situation but at this frequency the problem of klystron dimensions is encountered. Recent developments of RFQ technology allow some of these difficulties to be overcome by forming a bridge between the injector (which thus can operate at a few tens of kV) and the beginning of the accelerator (which then use an RF frequency at least twice as high). Klystrons are now perfectly adapted for operation in this frequency range (350-500 MHz). Very high-performance klystrons have been developed for electron accelerators. Klystrons can cover the entire frequency range necessary for multi-GeV proton accelerators. The present-day possibilities are discussed and improvements which can be anticipated in the near future are described.

25571 (SLAC—303, pp 125-127) **Vacuum system design considerations of the Los Alamos Accelerator Test Stand (ATS).** Wilson, N.G. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The accelerator test stand (ATS), in operation at the Los Alamos National Laboratory, includes a hydrogen ion source, low- and high-energy beam-transport sections, and a 425-MHz radio-frequency quadrupole (RFQ) linear accelerator. A 425-MHz drift-tube linac (DTL) and a powered buncher matching section have been constructed and will be installed on the ATS. The vacuum systems required for the various sections of the ATS are designed to provide (1) high gas-load capability, as required in the high-power, and (2) high-vacuum capability in the high-power, radio-frequency accelerator sections (where fast vacuum-system response time is of importance) through the use of distributed, differential pumping as a principal vacuum-system feature. Properties of accelerator materials, vacuum-systems engineering and analysis, vacuum equipment used, and ATS vacuum-system performance are discussed.

25572 (SLAC—303, pp 128-130) **Fabrication and tuning techniques for side-coupled electron accelerator structures.** Hansborough, L.D.; Clark, W.L.; DePaula, R.A.; Martinez, F.A.; Roybal, P.L.; Wilkerson, L.C.; Young, L.M. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Beginning in 1979, Los Alamos entered into a collaboration with the National Bureau of Standards (NBS) to develop an advanced cw microtron accelerator. The accelerating structures (one 0.9-m-long, one 2.7-m-long, and two 4.0-m-long) containing a total of 184 accelerating cavities have been fabricated and tuned to the 2380-MHz operating frequency. New methods simplified the fabrication of these structures and eliminated several furnace-brazing steps. These fabrication methods, lathe-mounted tuning fixtures, and streamlined tuning techniques were developed to allow efficient production of side-coupled structures. These techniques are now being applied to the 2450-MHz racetrack microtron accelerator structures being fabricated at Los Alamos for the Nuclear Physics Department of the University of Illinois. Refinements of the described techniques will allow future accelerators of this type to be fabricated by private industry.

25573 (SLAC—303, pp 131-133) **Status of the BNL 200 MeV linac.** McNerney, A.; Brennan, J.M.; Briscoe, B.; Brodowski, J.; Horton, R.; LoDestro, V.; Montemurro, P.; Zhang, S.Y. (Brookhaven National Lab., Upton, NY). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The BNL 200 MeV Linac normally accelerates H^- ions during its operating schedule. During selected periods, typically of six to ten weeks duration, polarized H^- ions are accelerated. Since Linac H^- commissioning, longer 7835 tube lives have been recorded and after initial operating bugs were eliminated, preinjector reliability has improved. Hardware components in the Preinjector, rf system, and ion source have been replaced or upgraded, and plans are being implemented for future system improvements. BLIP operations were initially curtailed during polarized beam running and a pulsed magnet has been installed in LEBT to restore BLIP running time to original levels.

25574 (SLAC—303, pp 141-143) **Compact proton linac for positron tomography.** Hamm, R.W.; Crandall, K.R.; Hamm, M.E.; Hansborough, L.D.; Potter, J.M. (AccSys Technology, Inc., Pleasanton, CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The design of a compact proton linac for use in positron emission tomography (PET) has been completed, and a prototype is presently under construction. This linac is based on technology demonstrated at Los Alamos National Laboratory under the PIGMI program funded by the National Cancer Institute. The design presented here combines that technology with recent developments and new rf power sources to produce a practical and economical radioisotope production accelerator for PET.

25575 (SLAC—303, pp 144-147) **SLAC low emittance accelerator test facility.** Loew, G.A.; Miller, R.H.; Sinclair, C.K. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

SLAC is proposing to build a new Accelerator Test Facility (ATF) capable of producing a 50 MeV electron beam with an extremely low geometric transverse emittance (1.5 x 10^{-10} rad x m) for the purpose of testing new methods of acceleration. The low emittance will be achieved by assembling a linear accelerator using one standard SLAC three-meter section and a 400 kV electron gun with a very small photocathode (40 microns in diameter). The photocathode will be illuminated from the back by short bursts (on the order of 6 ps) of visible laser light which will produce bunches of about 10^5 electrons. Higher currents could be obtained by illuminating the cathode from the front. The gun will be mounted directly against the accelerator section. Calculations show that in the absence of an RF buncher, injection of these 400 keV small radius electron bunches roughly 30^0 ahead of crest produces negligible transverse emittance growth due to radial RF forces. Acceleration of the electrons up to 50 MeV followed by collimation, energy slits and focusing will provide a 3.2 mm long waist of under 1.5 $^{+}$m in diameter where laser acceleration and other techniques can be tested.

25576 (SLAC—303, pp 148-150) **Post coupler studies for Alvarez tanks.** Sawamura, M.; Iwashita, Y.; Takekoshi, H. (Kyoto Univ., Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Field distributions of drift tube linacs (DTL) with post couplers were measured in three models. They have three different ratios of drift tube-to-wall spacing to one-quarter wave-length (λ/d). As the ratio becomes large, the limited range of post coupler length makes difficult to stabilize the field. But the ratios of post coupler length to $\lambda/4$ at stabilization were almost same in each model. The equivalent circuit model of DTL with post couplers were compared with measurements. For another stabilization idea, strip lines were installed in the tank and the field stabilization was observed.

25577 (SLAC—303, pp 151-153) **Q value of DAW linac with biperiodic T stem.** Iwashita, Y.; Abe, S.; Takekoshi, H. (Kyoto Univ., Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Two sets of large radius disk and washer (DAW) test cavity with biperiodic 4-T stem were studied for the T-stem effect to Q-value degradation and coupling mode frequency. Two shapes of T stem were tested. The frequency was 1300MHz and 2380MHz, and $\beta=1.0$. The overlapping problem connecting with the large radius for high shunt impedance was solved by the biperiodic 4-T stem geometry. The cavity radius was 0.767λ and 0.786λ. The Q value degradation introduced by the stem was evaluated by comparing with the non-stem geometry which was achieved by nylon string hanging. The coupling and accelerating mode frequency compensation method was also investigated to cancel the biperiodic perturbation to electric field distribution along the axis.

25578 (SLAC—303, pp 160-162) **Unified formulation for linear accelerator design.** Farkas, Z.D. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Expressions for peak and average powers required to produce a given average gradient in an accelerator section are given. They are valid for both lossy and lossless (superconducting) sections, for both traveling wave and standing wave sections, and for pulsed or continuous wave rf input. The expressions are given in terms of structure parameters that are equally applicable to traveling wave or standing waves. These parameters delineate the effect of wall losses and energy required to build up the field. For both traveling wave and standing wave sections it is possible to make the rf pulse length short enough to make the wall losses negligible at the expense of increased peak power requirement. Therefore, the expressions includes the effects of pulse compression.

25579 (SLAC—303, pp 200-205) **Comparison of standing-wave and traveling-wave structures.** Miller, R.H. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The controversy over the relative advantages of standing-wave and traveling-wave linear accelerators is now in its fourth decade. It has been fed by a considerable body of misinformation. It is hoped that some light may be shed on the subject, and expose some of the falsehoods. The discussion is directed toward the question of which structure to use for short pulse high field electron accelerators since it is almost universally accepted that standing-wave structures are appropriate for CW and long pulse accelerators. Three arguments against standing-wave accelerators are discussed and shown to be invalid.

25580 (SLAC—303, pp 209-213) **Progress report on the SLAC Linear Collider.** Rees, J. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The SLAC Linear Collider project (SLC) which began formally in October 1983 is nearing completion. Some systems of the collider have been completed and brought into service, some are being completed this month, and the last systems are scheduled to be finished by the end of November. The project is slightly behind schedule, having originally been scheduled to be complete by the end of September, but progress has been good and no major obstacles now appear to stand in the way of completion. The main performance specifications of the SLC are shown. The performance hoped to attain with the collider in its initial form is shown. Eventual goals - goals which exceed those set forth originally are discussed. The principal differences in the physical machine between the two columns are in the repetition rate and the final demagnification. The collider will operate initially at repetition rates up to 120 Hz rather than 180 Hz and the final demagnifying lens system uses iron magnets instead of superconducting magnets.

25581 (SLAC—303, pp 220-224) **Advanced technology recently developed at KEK for future linear colliders.** Tanaka, J. (National Lab. for High Energy Physics, Ibaraki-ken, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

For the future high energy accelerators such as SSC and SLC, high field accelerator structures and high power rf sources will play much more important roles. However, in many cases, the ceiling of the dc or rf field strength and of the rf power is practically restricted within a limit of breakdown at the vacuum side surfaces of the rf structure and insulator or at the inside of insulator. To realize extremely high field or super rf power, not only the basic study of the materials composing the rf structures but also the production process control of the materials are indispensable. Technologies developed and experienced at the KEK accelerators are described. Some of them will be available for development of the next generation accelerators.

25582 (SLAC—303, pp 227-231) **RFQ's in research and industry.** Staples, J. (Lawrence Berkeley Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC03-76SF00098.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The Radio Frequency Quadrupole accelerator (RFQ) has now matured to the point where it has found wide application. Many machines are in use as part of a synchrotron injector chain with others in unique and unusual applications. Several new RFQ's are now under construction of operating since the last survey. They are of various configurations, making use of various techniques of fabrication and field stabilization. Duty factors are being pushed up, new beam dynamics design techniques are used and emittance blow up mechanisms are better understood. Finally, RFQ's are moving from the laboratory to the commercial marketplace.

25583 (SLAC—303, pp 243-248) **Rf cavity design and codes.** Weiland, T. (Deutsches Elektronensynchrotron DESY, Hamburg, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The design of rf cavities by means of computer codes is already well established. Recently, more and more complete and versatile computer codes have been written that cover almost all possible problems that an be solved by two-dimensional meshing. Cavities without any simple symmetry (such as cylindrical or translational) have to be treated fully three-dimensionally. To date, the MAFIA CAD system by the DESY/KfA-Juelich/LANL collaboration seems to be the most highly developed family of codes. Three-dimensional computations of resonant modes have proven their accuracy in comparison with many measurements. The accuracy seems to be limited only by the size of available computers. IBM computers can handle up to 100,000 grid points, and the CRAY-2 up to 2,000,000 nodes, but no experience has been gathered so far with such large meshes. Three-dimensional computations for transient cavity wake fields have been used in designing accelerator components for some time but due to complexities, there are no measurements with which to compare. The largest meshes one can use for transient fields are much larger than for resonance calculations (over 1,000,000 on IBM, say). Under the assumption that bigger computers with memories of some ten megawords will soon become widely available, 3D codes can come into routine use as have the two-dimensional codes for years. However, even with the restricted core size, these codes can help to gain significant understanding of truly three-dimensional structures.

25584 (SLAC—303, pp 257-259) **Design of a single pulse accelerator.** Schempp, A. (Universitaet Frankfurt am Main, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

For neutron time-of-flight experiments short proton beam bunches with pulse pauses of up to several μsec are needed. Such high pulse current proton accelerators can replace electron linacs of the ORELA type. The injector of such a new system will favorably be an RFQ. An RFQ-design is presented, which produces single pulses of 5 x 10^9 protons (1 nsec width) with repetition rates between 1 Hz and 20 MHz. Such an RFQ-scheme can also be used to produce empty buckets (beam pauses) for high current linacs injecting into synchrotrons, as discussed for the European Hadron Facility accelerator (EHF).

25585 (SLAC—303, pp 269-271) **Development of a heavy-ion linac based on super conducting intradigital accelerating structures.** Shepard, K.W. (Argonne National Lab., IL). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract W-31-109-ENG-38.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Four types of superconducting accelerating structures are being developed for use in a low-velocity positive-ion injector linac planned for ATLAS heavy-ion accelerator. A prototype of the first of these, an interdigital four-gap structure, has been completed and tested at accelerating gradients up to 10 MV/m, corresponding to a maximum surface electric field of 40 MV/m and an effective accelerating potential of 1 MV/resonator. The 48.5 MHz resonant cavity has an active length of 10 cm and is designed for particle velocities in the range $0.007\ c < v < 0.014c$. Prototypes of the remaining three resonator types required for the linac are under construction.

25586 (SLAC—303, pp 302-304) **UNILAC as a fast switching, variable ion and energy accelerator.** Glatz, J. (GSI, Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Work is in progress to extend the Unilac heavy ion linear accelerator facility through the addition of a high current injector, a synchrotron (SIS), and a storage ring. For efficient operation of these facilities the scheme of time share operation has been adopted for the Unilac: beams of differing ion species and current will be extracted from one of three injectors, be accelerated to the desired energies and be delivered into one of three experiment areas or to the SIS. The performance of the Unilac under these operating conditions has been studied theoretically and experimentally, and it was found that dc powered focusing systems within accelerating tanks will accommodate the range of desired ions (Ne to U) and energies (3.6 to 16 MeV/μj). RF-systems, transverse matching sections and switching magnets are to be operated in a pulsed mode with varying fields.

25587 (SLAC—303, pp 305-307) **Low-β acceleration with a MEQALAC.** van Amersfoort, P.W.; Siebenlist, F.; Thomae, R.W.; Woljke, R.; Schonewille, F.G.; Ivanov, S.T.; Klein, H.; Schempp, A.; Weis, T. (FOM-Institute for Atomic and Molecular Physics, Amsterdam, Netherlands). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

In a Multiple Electrostatic Quadrupole Array Linear Accelerator (MEQALAC) a number of parallel beams is accelerated simultaneously. This devise is useful for exit energies up to 1 MeV per nucleon. Radial stability is provided by electrostatic quadrupole lenses placed between successive acceleration gaps. The proof-of-principle MEQALAC presently available at FOM features four He^+ ion beams which are accelerated to an energy of 120 keV. The resonator cavity has a modified Interdigital-H-structure and contains 20 acceleration gaps. Its resonance frequency is 40 MHz. Transmission measurements on injected beams with currents ranging from 1 to 15 mA are presented. The transverse phase advance per cell of the quadrupole channels is varied between 43° and 114°. A maximum current of 2.2 mA per channel has been accelerated. A design for a MEQALAC which will be used for acceleration of N^+ ions to 1 MeV is presented. This accelerator will be operated at various frequencies to allow for a variation of the exit energy.

25588 (SLAC—303, pp 311-314) **High current RFQ accelerator using a split coaxial resonator with a four rod structure.** Leipe, P.; Langbein, K.; Deitinghoff, H.; Klein, H.; Schempp, A. (Universitaet Frankfurt am Main, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A split coaxial resonator with a trapezoidally modulated four rod accelerating structure has been built to accelerate high currents of protons or H_2^+-ions to an energy of 46 keV/N. It will be used to investigate RFQ funneling and to study beam loading effects. First experiments showed that 70% of the current limit can easily be reached. Higher currents are expected by an upgrading of the RF power.

4302 Beam Dynamics, Field Calculations, And Ion Optics

REFER ALSO TO CITATION(S) 25464, 25523, 25530, 25534, 25575, 25586, 25587, 26123

25589 **(CONF-860629—69) High-current beam dynamics and transport, theory and experiment.** Reiser, M. (Maryland Univ., College Park (USA). Lab. for Plasma and Fusion Energy Studies). 1986. Contract AC05-85ER40216. 5p. NTIS MF A01; 2; GPO Dep. File Number DE87006154.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Recent progress in the understanding of beam physics and technology factors determining the current and brightness of ion and electron beams in linear accelerators will be reviewed. Topics to be discussed including phase-space density constraints of particle sources, low-energy beam transport include charge neutralization, emittance growth due to mismatch, energy exchange, instabilities, nonlinear effects, and longitudinal bunching.

25590 **(CONF-860629—71) Frequency scaling of linear super-colliders.** Mondelli, A.; Chernin, D.; Drobot, A.; Reiser, M.; Granatstein, V. (Science Applications International Corp., McLean, VA (USA); Maryland Univ., College Park (USA)). Jun 1986. Contract AC05-85ER40216. 4p. NTIS, PC A02. File Number DE87006654.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The development of electron-positron linear colliders in the TeV energy range will be facilitated by the development of high-power rf sources at frequencies above 2856 MHz. Present S-band technology, represented by the SLC, would require a length in excess of 50 km per linac to accelerate particles to energies above 1 TeV. By raising the rf driving frequency, the rf breakdown limit is increased, thereby allowing the length of the accelerators to be reduced. Currently available rf power sources set the realizable gradient limit in an rf linac at frequencies above S-band. This paper presents a model for the frequency scaling of linear colliders, with luminosity scaled in proportion to the square of the center-of-mass energy. Since wakefield effects are the dominant deleterious effect, a separate single-bunch simulation model is described which calculates the evolution of the beam bunch with specified wakefields, including the effects of using programmed phase positioning and Landau damping. The results presented here have been obtained for a SLAC structure, scaled in proportion to wavelength.

25591 **(DOE/ER/40048—190-L7) LYRAN: A program for the analysis of linac beam dynamics.** Lu, J.Q.; Ben-Zvi, I.; Cramer, J.G. (Washington Univ., Seattle (USA). Nuclear Physics Lab.). [1987]. Contract AC06-81ER40048. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007123.

The FORTRAN program LYRAN has been written for use in analyzing the beam dynamics of superconducting heavy ion linacs. The program is based on the program LYRA developed by A.H. Scholldorf at SUNY Stony Brook, but that original program has been extensively extended, modified, and restructured. LYRAN transports a group of input particles randomly distributed on a selected distribution function through linac elements which include RF accelerating and bunching elements, dipole and quadrupole magnets, electrostatic elements, and drift spaces. Second order corrections to dipoles and quadrupole fields are included. A nonlinear optimization routine is incorporated, providing fast and efficient determination of accelerator configurations and parameter settings that provide desired beam properties. Beam envelope plotting is also included to provide graphic display of beam characteristics.

25592 **(LA-UR—87-896) New documentation from the Los Alamos accelerator code group.** Cooper, R.K.; Menzel, M.T.; Stokes, H.K.; Warren, J.L. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 9p. (CONF-870302—23). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007485.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

Brief descriptions are given for MAFIA and POISSON/SUPERFISH are given. MAFIA is a computer-aided analysis and design of three-dimensional electromagnetic structures including electrostatic and magnetostatic devices, radio-frequency cavities, bellows, etc. The POISSON/SUPERFISH is a group of codes used in the computer-aided design of magnets and radiofrequency structures.

25593 (LBL—22176) **Harmonic-error-analysis measurements of dipole and quadrupole magnets at Lawrence Berkeley Laboratory.** Green, M.I.; Barale, P.J.; Nelson, D.H.; Van Dyke, D.A. (Lawrence Berkeley Lab., CA (USA)). 1987. Contract AC03-76SF00098. 6p. (CONF-870302—14). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006937.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

Error harmonics are detected using slowly rotating search-coil arrays feeding a digital integrator. The fundamental signal is detected during the first rotational cycle. The search-coil arrays are reconfigured to "buck" the fundamental and lower harmonics during the second rotational cycle, allowing the measurement of higher harmonics with excellent resolution. Data are first drift corrected, then harmonic analyzed using the fast Fourier transform technique. The measurements, data processing, and generation of both tabular and graphic output require about 80 seconds. Data are later postprocessed using spreadsheets allowing easy manipulation and comparison of measurements during a test series and between magnets. Hardware and software will be described. Accuracy, precision, and resolution will be discussed, and the measurement technique for Superconducting Super Collider (SSC) model magnets will be described.

25594 (SAND—86-2154C) **The design of the accelerating gaps for the linear induction accelerator RADLAC II.** Shope, S.L.; Mazarakis, M.G.; Miller, R.B.; Poukey, J.W. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 3p. (CONF-870302—15). NTIS, PC A02. File Number DE87007026.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

In high current (50 kA) linear induction accelerators, the accelerating gaps can excite large radial oscillations. A gap was designed that minimized the radial oscillations and reduced potential depressions. The envelope equation predicted radial oscillation amplitudes of 1 mm which agreed with experimental measurements.

25595 (SAND—86-2155C) **Acceleration and bending of a relativistic electron beam on the Sandia Recirculating Linac.** Shope, S.L.; Tucker, W.K.; Hasti, D.E.; Poukey, J.W.; Kamin, G.W.; Rienstra, W.W. (Sandia National Labs., Albuquerque, NM (USA); Science Applications International Corp., McLean, VA (USA)). 1987. Contract AC04-76DP00789. 3p. (CONF-870302—16). NTIS, PC A02. File Number DE87007082.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

Ion focused transport is used to generate and transport a relativistic electron beam in a recirculating linac. An ionized channel is formed in 0.06 to 0.2 mTorr of argon with a low energy e-beam that is contained and guided by a 200 G magnetic field. A 1.5-MeV, 20-kA beam has been generated in the injector and accelerated to 2.5 MeV by the accelerating cavity. Results of experiments on transporting and bending the beam through 270° are presented.

25596 (SAND—86-2254C) **Two cavity autoacceleration of an intense relativistic electron beam.** Coleman, P.D.; Lockner, T.R.; Poukey, J.W. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 4p. (CONF-870302—7). NTIS MF A01; 2; GPO Dep. File Number DE87006892.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

Three series of experiments have been performed using two 40 Ω coaxial autoacceleration cavities to accelerate an intense relativistic electron beam. First, conventional magnetic transport was used to propagate a 1.8 MeV, 11 kA beam through two 1 m long cavities. An increase of 700 +- 130 keV in kinetic energy was achieved which represents 80% of the maximum theoretical acceleration for an 11 kA beam passing through two 40 Ω cavities. Multiple accelerated pulses were generated and no adverse interaction between the cavities was observed. In the second experiment, Ion Focused Transport (IFT) was used to successfully propagate a 9 kA beam through the accelerator again achieving multi-pulse operation with both cavities. An energy increase of 560 +- 30 keV was attained which is 78% of the theoretical maximum. Finally, IFT was used to propagate a ≃25 kA beam through a 1 m long cavity, then a 0.5 m long cavity, demonstrating two stages of temporal energy compression. Gap leakage and current transport losses limited the acceleration to 1.25 +- .16 MeV which corresponded to an 84% increase in kinetic energy.

25597 (SLAC—303, pp 336-339) **Numerical studies of emittance exchange in 2-D charged particle beams.** Guy, F.W.; Wangler, T.P. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Results obtained from a two-dimensional particle-following computer code that simulates a continuous, nonrelativistic, elliptical charged-particle beam with linear continuous focusing are presented. Emittances and focusing strengths can be different in the two transverse directions. The results can be applied, for example, for a quadrupole transport system in a smooth approximation to a real beam with unequal emittances in the two planes. The code was used to study emittance changes caused by kinetic-energy exchange between transverse directions and by shifts in charge distributions. Simulation results for space-charge-dominated beams agree well with analytic formulas reported in these proceedings. From simulation results, an empirical formula was developed for a partition parameter (the ratio of kinetic energies in the two directions) as a function of initial conditions and beamline length. Quantitative emittance changes for each transverse direction can be predicted by using this parameter. Simulation results also agree with Hofmann's generalized differential equation relating emittance and field energy.

25598 (SLAC—303, pp 340-345) **Influence of equipartitioning on the emittance of intense charged-particle beams.** Wangler, T.P.; Guy, F.W.; Hofmann, I>. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The ideas of kinetic energy equipartitioning and nonlinear field energy are combined to obtain a quantitative description for rms emittance changes induced in intense beams with two degrees of freedom. Equations are described for emittance change in each place for continuous elliptical beams and axially symmetric bunched beams, with arbitrary initial charge distributions within a constant focusing channel. The complex details of the mechanisms leading to kinetic energy transfer are not necessary to obtain the formulas. The resulting emittance growth equations contain two separate terms: the first describes emittance changes associated with the transfer of energy between the two planes; the second describes emittance growth associated with the transfer of nonlinear field energy into kinetic energy as the charge distribution changes.

25599 (SLAC—303, pp 349-351) **Understanding scaling laws.** Lysenko, W.P. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Accelerator scaling laws how they can be generated, and how they are used are discussed. A scaling law is a relation between machine parameters and beam parameters. An alternative point of view is that a scaling law is an imposed relation between the equations of motion and the initial conditions. The relation between the parameters is obtained by requiring the beam to be matched. (A beam is said to be matched if the phase-space distribution function is a function of single-particle invariants of the motion.) Because of this restriction, the number of independent parameters describing the system is reduced. Using simple models for bunched- and unbunched-beam situations. Scaling laws are shown to determine the general behavior of beams in accelerators. Such knowledge is useful in design studies for new machines such as high-brightness linacs. The simple model presented shows much of the same behavior as a more detailed RFQ model.

25600 (SLAC—303, pp 371-373) **Beam test of the RFQ linac TALL.** Ueda, N.; Mizobuchi, A.; Yamada, S.; Arai, S.; Olivier, M.; Nakanishi, T.; Fukushima, T.; Tatsumi, S.; Hirao, Y. (Univ. of Tokyo, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Field tuning and beam test of the RFQ linac TALL were done. The machine is designed to accelerate heavy ions with charge to mass ratio of 1 ~ 1/7. The acceleration cavity is of four vane structure driven with a single loop coupler. The cavity is 58 cm in diameter and 730 cm in length. No vane coupling ring is used. A field uniformity was obtained within an error of +/- 2% azimuthally and +/- 5% longitudinally by use of side inductive and end capacitive tuners. The TE210 mode was tuned at 101.3 MHz, 0.9 MHz lower than that of the closest mode TE111. Beam test was done by using proton beams. Transmission exceeding 90% was obtained. Energy and its magnet as T = 825 keV and AT/T = 1.6% in FWHM. They agree with calculated values.

25601 (SLAC—303, pp 380-382) **Computer program for beam phase space with arbitrary configuration.** Shinian, F.; Yinbao, C.; Xi, X. (Institute of Atomic Energy, Beijing, China). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A computer program intended for the beam transport system design of an initial beam phase space with arbitrary configuration was developed and some practical examples are given to show the application of the program.

25602 (SLAC—303, pp 441-443) **SLC energy spectrum monitor using synchrotron radiation.** Seeman, J.; Brunk, W.; Early, R.; Ross, M.; Tillmann, E.; Walz, D. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The SLAC linac is being upgraded for the use in the SLAC Linear Collider (SLC). The improved linac must accelerate electron and positron bunches from 1.2 GeV to 50 GeV while producing output energy spectra of about 0.2%. The energy spectra must be maintained during operation to provide for good beam transmission and to minimize chromatic effects in the SLC ARCs and Final Focus. The energy spectra of these beams are determined by the bunch length and intensity, the RF phase and waveform and the intra-bunch longitudinal wakefields. A non-destructive energy spectrum monitor has been designed using a vertical wiggler magnet located downstream of the horizontal beam splitter at the end of the SLC linac. It produces synchrotron radiation which is viewed in an off-axis x-ray position sensitive detector. The expected resolution is 0.08 %. The design considerations of this monitor are presented. A pair of these monitors is under construction with an installation data set for late summer 1986.

25603 (SLAC—303, pp 449-451) **Optics of beam recirculation in the CEBAF CW linac.** Douglas, D.R. (Continuous Electron Beam Accelerator Facility, Newport News, VA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The use of recirculation in linear accelerator designs requires beam transport systems that will not degrade beam quality. A design for the transport lines to be used during recirculation in the CEBAF accelerator is presented. These beam lines are designed to avoid beam degradation through synchrotron radiation excitation or betatron motion mismatch, are insensitive to errors commonly encountered during beam transport, and are optimized for electron beams with energies of 0.5 to 6.0 GeV. Optically, they are linearly isochronous second order achromats based on a missing magnet FODO structure. Lattice specifications and results of analytic estimates and numerical simulations of the performance of the beam transport system are given.

25604 (SLAC—303, pp 452-454) **Multipass beam breakup in the CEBAF superconducting linac.** Bisognano, J.J. Krafft, G.A. (Continuous Electron Beam Accelerator Facility, Newport News, VA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Multipass beam breakup can severely limit current in superconducting linear accelerators due to the inherently high Q's of transverse deflecting modes of the RF cavities. The success of higher-order-mode damping in increasing threshold currents for the 4-pass CEBAF SRF linac design is investigated with computer modeling. This simulation is shown to be in agreement with theoretical analyses which have successfully described beam breakup in the Stanford superconducting, recirculating linac. Numerical evaluation of an analytic treatment by Gluckstern of multipass beam breakup with distributed cavities is also found to be consistent with the computer model. Application of the simulation to the design array of 400 five-cell CEBAF/Cornell cavities with measured higher-order-mode damping indicates that the beam breakup threshold current is at least an order of magnitude above the CEBAF design current of 200 $^{+}$A.

25605 (SLAC—303, pp 461-464) **RF breakdown studies in a SLAC disk-loaded structure.** Wang, J.W.; Nguyen-Tuong, V.; Loew, G.A. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

RF breakdown studies in an S-band standing-wave disk-loaded accelerator structure have been completed. An equivalent traveling-wave accelerating gradient as high as 147 MV/m and a peak field in excess of 300 MV/m have been obtained. At these high gradients, considerable amounts of field emission and x-ray radiation are observed. Some of the field-emitted electrons are captured and focused by the RF fields and can be extracted on the axis of the structure. Their current, energy distribution and the x-ray radiation they produce are given. RF processing as measured by the frequency of breakdown and the reduction in field emitted electron currents inside the structure can be speeded up considerably by the presence of argon. Some conjectures on the causes of breakdown are presented.

25606 (SLAC—303, pp 465-468) **First electron beams from the LFP injector linacs.** Warner, D.J. (CERN, Geneva, Switzerland). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The commissioning of the LEP Injector Linacs (LIL) with beams is now taking place at CERN. Acceleration of electrons to 265 MeV has been achieved by 6 sections of the 600 MeV linac (LIL W) and the beam transported to the electron injection line of the Electron Positron Accumulator (EPA). Preliminary measurements of energy, energy spread and emittance are reported for the maximum energy, with more details of measurements at intermediate energies, nominally 4 MeV and 100 MeV, and of experience gained in commissioning the rf systems including LIPS, and the beam instrumentation. It is too early to claim comprehensive agreement of measurements with design parameters but no fundamental limitations have been found.

25607 (SLAC—303, pp 469-471) **Simulation of trajectory control in LIL.** Chehab, R.; Thiery, Y. (Universite de Paris-Sud, Orsay, France). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The beam displacement due to misalignment errors of the quadrupoles in the FODO array of the 600 MeV LEP Injector Linac (LIL) is simulated using 30 statistically independent sets. The effects of displacement and inclination are compared. Taking into account the random errors in the position measurements, a trajectory correction scheme using small corrector dipoles is tried out on this sample of 30 FODO arrays. It is shown that about five correctors are required to reduce the peak distortion to less than 1 mm at the position monitors. The aperture margin is increased by a factor 10 on average in the most critical places.

25608 (SLAC—303, pp 472-474) **Design of a high intensity electron buncher.** Tronc, D.; Bourat, C.; Georges, J.P.; Setty, A.; Sparato, B. (Thomson-CGR MeV, Buc, France). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A 2856 MHz high intensity electron injector derived from the CERN-LIL front end will be installed in December 1986 at the beginning of the Frascati $e^+ e^-$ linac. The longitudinal dynamics at the beginning of the buncher where a new geometry increases the electron capture are analyzed. Simulation results are presented taking account of the radial dynamics and of the space-charge effects. Comparison is made between an ellipsoidal space-charge model, the ESPEL code and a modified version of the PARMELA code. This injector is the prototype of a moderate cost unit designed to accelerate up to 100 nanocoulomb without constraints on adjustments of sensitive parameters.

25609 (SLAC—303, pp 475-477) **Beam-beam deflections as an interaction point diagnostic for the SLC.** Bambade, P.; Erickson, R. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A technique is described for non-destructive measurement and monitoring of the steering offset of the electron and positron beams at the interaction point of the SLC, based on using stripline beam-position monitors to measure the centroid of one beam as it is deflected by the opposing beam. This technique is also expected to provide diagnostic information related to the spot size of the micron-size beams.

25610 (SLAC—303, pp 478-479) **Beamstrahlung monitor for SLC final focus using gamma ray energies.** Bonvicini, G.; Field, C.; Minten, A. (Univ. of Michigan, Ann Arbor). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Features of the beamstrahlung flux from the SLC interaction point are discussed, and intensity estimates given. A Cherenkov detector intended to monitor the flux is described.

25611 (SLAC—303, pp 480) **Beamstrahlung monitor for SLC final focus using visible wavelengths.** Bonvicini, G.; Ferrie, J.; Field, C.; Minten, A. (Univ. of Michigan, Ann Arbor). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The production and detection of small angle beamstrahlung at energies $\sim >$ 30 MeV has been previously discussed. The theory has been extended to emission at wide angles and wavelengths near the visible. In the case of visible light at about 7.5 mrad, the exponential factor is about 0.95, and is insensitive to small changes in its parameters. So, at fixed angle the visible beamstrahlung signal is closely related to the luminosity for head on collisions of the beams. The expected size of the signals at SLC is limited by severe geometrical constraints. The possible access position is 43 cm beyond a synchrotron radiation mask. It is necessary to keep the inner edge of the device at a greater radius than that of the mask to preserve the masking efficiency. The mask shadows the interaction point emission at the outer radius of the beamstrahlung monitor, and leaves only a 0.5 mrad aperture at about 7.5 mrad. A schematic drawing of one channel of such a device is shown. For higher luminosities the device promises to be a useful monitor of beam size variations. It is almost totally different from the high energy beamstrahlung technique, and so provides a measure of independence to the interaction point diagnostics.

25612 (SLAC—303, pp 484-486) **Image processing system for electron linac beam diagnosis.** Liu, D.K.; Nakahara, K.; Abe, I.; Urano, T.; Enomoto, A.; Tanaka, J. (Institute of High Energy Physics, Beijing, China). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

For diagnosis of electron linac beams, image signals from a TV camera viewing a ceramic screen monitor were processed and analyzed using a waveform digitizer and a personal computer. The black-and-white TV camera used has a zoom lens with a remote-controllable iris; the automatic gain control circuit was switched off to obtain tolerable linearity of the output video signal against the brightness of the beam spot on the screen. The video signals are taken by the waveform digitizer with a sampling rate of 4 MHz; the digitized picture is transmitted to the personal computer via the GPIB and is analyzed to derive spatial intensity distribution of the beam. The sync signal of the TV camera is externally synchronized with the electron linac beam timing.

25613 (SLAC—303, pp 490-492) **Deflection by the image current and charges of a beam scraper.** Bane, K.L.F.; Morton, P.L. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Scrapers are often used in storage rings and accelerators to clean-up the transverse profile of the beam. When the beam is not exactly midway between the jaws of the scraper the transverse electric and magnetic fields produced by the image charges and currents are asymmetric. For a relativistic beam traveling through a longitudinally uniform tube with infinitely conducting walls the transverse force from the electric field is canceled by the transverse force from the magnetic field, to order $1/\gamma^2$, where γ is the particle energy. However, when an off-center particle bunch passes by a longitudinal discontinuity in the beam tube the transverse force from the electric field is no longer canceled by the transverse force from the magnetic field and particles in the bunch will experience a transverse momentum kick which is independent of energy. The necessary assumption is that the distance between the scraper jaws is small compared to the longitudinal extent of the beam bunch and the scraper. Scrapers also affect the energy of the beam.

25614 (SLAC—303, pp 520-522) **Improvement of the electron injection for the ALS electron linac.** Aune, B.; Damsin, P.; Corveller, P.; Jablonka, M.; Joly, J.M.; Juillard, M. (CEN Saclay, Gif-sur-Yvette, France). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A smaller transverse beam emittance has been a long-required improvement at the ALS electron linac. The goal has been reached by installing a new electron gun, designing a new transition beam line between the gun and the buncher, and changing the first focusing solenoids to more axially symmetric ones. These transformations resulted in a noticeable reduction of the beam emittance as well as in an improvement of the injector accessibility, monitoring and understanding. These modifications are described.

25615 (SLAC—303, pp 526-530) **Present optics options for TeV colliders.** Spencer, J.E. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A practical approach for implementing TeV collider optics with high luminosities $L \approx 10^{33}\ [\mathrm{cm}^2\ \mathrm{s}]^{-1}$ but without large pinch effects is given using current alternatives. Characteristics are considered that constrain the optics and the type and orders of magnets required. A modified linac FoDo cell based on permanent magnet hybrid quadrupoles is discussed. Similarly, a demagnifying, permanent magnet telescopic system that allows variation of beta, eta and energy is suggested for the final focus. The basic cell for low emittance damping rings can also be constructed solely from permanent magnets. Small diameter, low permeability, high field permanent magnets. Small diameter, low permeability, high field permanent magnets have proven useful for injection and extraction lines and are also compatible with the large particle detectors near the interaction regions as well as with exotic experiments for production and use of secondary beams or for multi-bunch coalescing schemes for control of longitudinal bunch distribution. An 8-10 GeV prototype cell and final focus experiment is propose to verify and study such systems as well as do some interesting physics tests. One example, which could be used with the PEP storage ring, would convert an external electron beam into a photon beam to avoid beamstrahlung effects - a major problem for high energy e+/= colliders.

25616 (SLAC—303, pp 534-536) **Experimental investigation of beam generation, acceleration, transport, and extraction in the RADLAC-II pulsed transmission line linear accelerator.** Mazarakis, M.G.; Leifeste, G.T.; Shope, S.L.; Frost, C.A.; Freeman, J.R.; Poukey, J.W.; Stygar, W.A.; Ekdahl, C.A.; Smith, D.L.; Johnson, D.L.; Hastl, D.E. (Sandia National Labs., Albuquerque, NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC04-76DP00789.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The generation, acceleration, transport, and extraction of intense, high-voltage relativistic electron beams with the RADLAC-II accelerator were investigated. A 40-KA, electron beam was produced by a foilless diode injector, which was immersed in, and accurately aligned with, the magnetic axis of a 17-kG solenoidal guide field. The solenoidal field guides the beam through the accelerator, which includes a number of post-accelerating gaps designed to provide radial force balance to suppress radial oscillations. Furthermore, the accelerating cavities have a very low Q and small transverse shunt impedance to suppress beam breakup instabilities. A 70% to 90% transport efficiency was observed, depending on the precision of the beam line alignment. Finally, the beam was extracted, without significant losses, and propagated into a magnetic field-free, air-filled region.

25617 (SLAC—303, pp 537-539) **Ion focused transport experiments.** Frost, C.A.; Shope, S.L.; Ekdahl, C.A.; Poukey, J.W.; Freeman, J.R.; Leifeste, G.T.; Mazarakis, M.G.; Miller, R.B.; Tucker, W.K.; Godfrey, B.B. (Sandia National Lab., Albuquerque, NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC04-76DP00789.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A new technique was developed for generating ionized channels for electrostatically guiding high current relativistic electron beams with ion focused transport (IFT). In IFT, beam electrons are electrostatically focused by a positive ion core left after the plasma electrons are ejected by the beam charge. The new method for channel formation allows beam transport over curved paths for applications in circular accelerators such as Sandia's recirculating linac, and also avoids the need for a UV laser. The authors technique uses a low-energy electron beam to ionize a guiding channel in a low pressure gas. A weak longitudinal magnetic field is applied to confine and guide the low-energy beam, enabling one to precisely define the ionization channel. The steady state channel produced by this technique has been diagnosed using Langmuir probes. Channel density and radius were then optimized for beam guiding. Using this method guided relativistic beams with currents exceeding 20 kA were guided over several meters and through a 90° bend. In these experiments with high nu/γ beams, erosion and instabilities which can be important for accelerator applications were observed. PIC simulations of IFT were performed and show stable propagation for high current beams passing through accelerating gaps.

25618 (SLAC—303, pp 540-542) **Cumulative beam breakup with a distribution of deflecting mode frequencies.** Gluckstern, R. Cooper, R.K.; Neri, F. (Univ. of Maryland, College Park). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The theory of beam breakup has been worked out for identical uncoupled cavities and for a constant beam current. The difference equations have been solved exactly for a coasting beam, and expressions have been obtained for the steady state solution where the input beam displacement is constant or modulated at an arbitrary frequency. In addition, an approximate result was obtained for the transient by means of a saddle point approximation. These results were shown to be in excellent agreement with numerical simulations for parameters appropriate to a 30 cavity 1300 MHz standing wave rf linear accelerator structure with a 2.5 Mev, 6.5 amp. coasting beam.

25619 (SLAC—303, pp 543-545) **Beam breakup in a multi-section recirculating linac.** Gluckstern, R.L. (Univ. of Maryland, College Park). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

It has long been recognized that recirculating a beam through a linac cavity in order to provide a more efficient acceleration can also lead to an instability in which the transverse displacement on successive recirculations can excite modes which further deflect the initial beam. The effect is of particular concern for superconducting rf cavities where the high Q (or order 10^9) implied low starting currents for the instability. Previous work has addressed this effect by calculating the beam trajectory in a single cavity, and its effect on excitation of unwanted modes. The analysis of Gluckstern, Cooper and Channel is extended to the case of recirculation of a CW beam, and the starting current for a multi-cavity structure with several recirculations is computed. Each of the cavities is assumed to provide a simple impulse to the beam proportional to the transverse displacement in that cavity.

25620 (SLAC—303, pp 580-581) **Beam emittance measurement on electron guns.** Naiquan, L.; Liang, F.; Zhixiu, G.; Wei, G. (Tsinghua Univ., Beijing, China). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The beam emittance of the electron gun with the direct emittance was measured. The experimental apparatus and measurement method are described and some results of the emittance measurements are discussed.

25621 (SLAC—303, pp 17-21) **Control of beam dynamics in high energy induction linacs.** Caporaso, G.J. (Livermore National Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract W-7405-ENG-48.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The advent of laser-ion-guiding in the Advanced Test Accelerator along with the development of accelerator cavities optimized with respect to beam breakup coupling impedance now make it possible to consider a new class of high current, high energy linear induction accelerators. The control of the beam breakup and other instabilities by laser guiding and by various magnetic focusing schemes is discussed along with the scaling laws for the design of such machines to minimize the growth of the beam breakup instability. Many linacs, particularly induction linacs are limited in performance by the beam breakup (BBU) instability. The instability is found in two forms. In the first form the accelerating cavities communicate with one another through interaction with the beam and through propagation of cavity fields through the accelerator structure. In the second form which is the more virulent of the two, the cavities couple to each other only through their interactions with the beam. It is this second form of BBU that is discussed.

25622 (SLAC—303, pp 50-52) **Longitudinal trapping and particle loss of high intensity bunched beams.** Pabst, M.; Bongardt, K. (Kerforschungsanlage Juelich, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

For a high intensity bunched beam the longitudinal acceptance usually is smaller than the beam emittance at injection energy. This causes longitudinal particle loss and emittance increase. A model is presented which explains the dynamics of the trapping procedure and the related particle loss for a high current bunched beam. The model is in qualitative agreement with numerical results obtained from multiparticle calculations. By varying the injection energy and the phase of the bunch center and the matching parameters of the beam the trapping efficiency can be improved.

25623 (SLAC—303, pp 62-64) **Proper input phase-space filling for accurate beam-dynamics codes.** Boicourt, G.P.; Vasquez, M.C. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

In the future, more attention will be required concerning the filling of the input phase space used by particle-simulation codes. The prospect of greatly improved particle-tracking codes implies that code input distributions must be accurate models of real input distributions. Much of present simulation work was done using artificial phase-space distributions (K-V, waterbag, etc.). Real beams can differ dramatically from such ideal input. A method has been developed for deriving code input distributions from measurements. The problem of determining the number of pseudoparticles needed to model the measured distributions properly is discussed.

25624 (SLAC—303, pp 65-69) **Internal dynamics and emittance growth in non-uniform beams.** Anderson, O.A. (Lawrence Berkeley Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC03-76SF00098.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Previous analytical studies related transverse rms emittance growth in non-uniform beams to changes in the beam density profile but did not analyze the time evolution of the process. A new approach analyzes the internal motion of the beam and then obtains the rms emittance explicitly as a function of time. It is shown to reach its peak value explosively in about one quarter of a plasma period. A uniformity criterion is given that determines whether or not the emittance oscillates periodically. Continuous initial density profiles are presented that lead to discontinuous shock-like behavior and segmented (beam-merging) profiles for which the rms emittance jumps to its maximum value in one-fourth of a plasma period and remains there with essentially no further change. Asymptotic behavior is briefly discussed.

25625 (SLAC—303, pp 81-84) **Beam dynamics, efficiency and power of the SLAC lasertron: simulation results.** Welch, J.J. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Results are presented of the computer simulation of the SLAC proof of principle lasertron device with a conventional single gap output cavity, using the 2D relativistic field and particle code called MASK. The RF-to-beam power efficiency is calculated for different power levels, DC voltages and optical pulse lengths. The calculated efficiency at the initial operating point of 50 MW beam power, 400 kV, and with 60 picosecond optical pulse duration, is 66%. The maximum RF power at 400 kV is about 50 MW. At 600 kV the maximum power increases to about 110 MW, but the efficiency at low power is not much changed from what it was at 400 kV. The simulations calculation does not take into account loss of RF power due to backscattered electrons nor the full effects of the impedance of the accelerating gap. A calculation of the efficiency of the lasertron with a double output cavity has been carried out by K. Eppley at SLAC, and generally yields efficiencies about 10 percentage points higher than the single cavity simulation.

25626 (SLAC—303, pp 85-86) **Maximum efficiency of a conventional klystron output cavity.** Welch, J.J. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

By using a photocathode instead of a thermionic cathode in a klystron, the possibility exists to make very short low energy spread bunches of high efficiency. However, there is a fundamental limit to the efficiency of a conventional output cavity, such as the one used in the SLAC XK-5 klystron. The fringing electric field in the drift tube acts on the beam as it leaves the output cavity and results in a net acceleration. All electrons which eventually reach the collector emerge from the drift tube with a substantial kinetic energy and as a result, the highest practical efficiency is about 80% for a 400 kV single output cavity tube. The behavior of these very short low energy spread bunches was calculated using MASK, a 2D field and particle program as well as a much simpler 1D program. Using multiple output cavities, it may be possible to extract energy from the electrons more efficiently.

25627 (SLAC—303, pp 87-89) **Collector material desorption tests.** Welch, J.J.; Sinclair, C.K. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

To obtain long cathode lifetimes, the surface of the spent beam collector for the photocathode RF power source (called the Lasertron) must have a low coefficient of desorption of gas molecules by electrons. A low voltage ($\leqq$ 10 kV) ultrahigh vacuum electron gun and target system assembled to measure the desorption rates of CO and CO$_2$ under conditions where the power density, charge density and pressure were the same order as expected in the lasertron. Copper coated with a thin layer of a nonevaporable getter (NEG) was found to have a coefficient of desorption of CO$_2$ (CO) at least 30 (5) times less than vacuum degassed high grade OFHC copper. The NEG material may be coated on the usual collector geometries and therefore can substantially reduce operating tube pressure in conventional klystron and other high current tubes.

25628 (SLAC—303, pp 101-103) **Longitudinal emittance measurement at the ATS.** Cottingame, W.B.; Cortez, J.H.; Higgins, W.W.; Sander, O.R.; Sandoval, D.P. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

With increasing brightness, beam diagnostic techniques requiring interception of the beam become impractical. For H$^-$ particle beams, solutions for this problem based on the phenomenon of photodissociation are now being investigated at the Los Alamos National Laboratory accelerator test stand (ATS). A laser can be used to selectively neutralize portions of the beam that can be characterized after the charged particles have been swept away. This technique has been used for measuring longitudinal emittance at the output of the ATS radio-frequency quadrupole (RFQ).

25629 (SLAC—303, pp 112-115) **Novel accelerators employing high-current electron beams: numerical simulations.** Fawley, W.M.; Teague, M.R.; Caporaso, G.J.; Yu, S.S.; Sessler, A.M. (Lawrence Livermore National Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Numerical simulation codes are described which can be used to study the physical phenomena of high-current electron beams employed in some novel accelerator schemes. Examples are given of the study of transverse effects in the free electron laser part of a Two-Beam Accelerator, the study of ion guiding in a relativistic klystron, and a study of the acceleration phase of a Collective Implosion Accelerator.

25630 (SLAC—303, pp 154-156) **Multiple-measurement beam probe.** Gilpatrick, J.D.; Grant, D.L. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Particle accelerators are becoming smaller and are producing more intense beams; therefore, it is critical that beam-diagnostic instrumentation provide accelerator operators and automated control systems with a complete set of beam information. Traditionally, these beam data were collected and processed using limited-bandwidth interceptive techniques. For the new-generation accelerators, a multiple-measurement microstrip probe is being developed to obtain broadband beam data from inside a drift tube without perturbing the beam. The cylindrical probe's dimensions are 6-cm o.d. by 1.0 cm long, and the probe is mounted inside a drift tube. The probe (and its associated electronics) monitors bunched-beam current, energy, and transverse position by sensing the beam's electromagnetic fields through the annular opening in the drift tube. The electrical impedance is tightly controlled through the full length of the probe and transmission lines to maintain beam-induced signal fidelity. The probe's small, cylindrical structure is matched to beam-bunch characteristics at specific beamline locations so that signal-to-noise ratios are optimized. Surrounding the probe, a mechanical structure attaches to the drift-tube interior and the quadrupole magnets; thus, the entire assembly's mechanical and electrical centers can be aligned and calibrated with respect to the rest of the linac.

25631 (SLAC—303, pp 171-175) **Highlights of the heavy ion fusion symposium.** Keefe, D. (Lawrence Berkeley Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC03-76SF00098.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The current status and prospects for inertial confinement fusion based on the use of intense beams of heavy ions will be described in the light of results presented at the International Symposium on Heavy Ion Fusion, (Washington, DC, May 27-29, 1986).

25632 (SLAC—303, pp 176-180) **High-current beam dynamics and transport, theory and experiment.** Reiser, M. (Univ. of Maryland, College Park). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Recent progress in the understanding of beam physics and technology factors determining the current and brightness of ion and electron beams in linear accelerators is reviewed. Topics discussed include phase-space density constraints of particle sources, low-energy beam transport including charge neutralization, emittance growth due to mismatch, energy exchange, instabilities, nonlinear effects, and longitudinal bunching.

25633 (SLAC—303, pp 183-187) **Emittance growth.** Hofmann, I. (GSI, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

With the growing interest in high-current linear accelerators a broader understanding of emittance growth has become desirable. Recently, the idea of relating emittance growth to the release of electrostatic field energy has been considered as a useful concept for a better understanding of the origin of emittance growth and for deriving simple estimates for growth under certain conditions. The derivation of generalized equations for emittance and field energy valid in periodic focusing and for continuous or bunched beams is outlined. Calculating the field energy for some standard models of charge distribution allows a direct estimate of the emittance growth due to initial mismatch. For the case of emittance transfer between different degrees of freedom due to intrinsic resonances (equipartitioning) an approximate formula is presented. These estimates are well confirmed by computer simulation.

25634 (SLAC—303, pp 214-219) **Special SLC linac developments.** Seeman, J.T.; Sheppard, J.C. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The linac of the SLAC Linear Collider (SLC) is required to accelerate several intense electron and positron bunches to high energy while maintaining their small transverse dimensions and energy spectra. Many of the linac systems have been upgraded to the new stringent SLC design criteria. The remaining systems will be completed in the summer of 1986. Special instruments and controls have been developed to monitor and manipulate these small but potent beams. A brief review of the SLC requirements is given. A broad survey of the recent developments is made encompassing longitudinal and transverse wakefield reductions, Landau damping, energy and position feedback systems, beam diagnostics and beam current fluctuations.

25635 (SLAC—303, pp 251-253) **Field stabilization with resonant line couplers.** Schempp, A. (Universitaet Frankfurt am Main, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A new concept of field stabilization of RFQ structures has been tested. Applications of these ideas on other RF acceleration structures are presented and properties of these resonant line couplers are discussed.

25636 (SLAC—303, pp 254-256) **Status of the HERA-RFQ injector.** Schempp, A.; Klein, H.; Schastock, P.; Pape, K.H.; Wang, S.H. (Universitaet Frankfurt am Main, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The HERA injector is a 18 keV to 750 keV RFQ for acceleration of a 20 mA H^- beam. The RFQ is under construction and will be ready for rf-tuning in June 1986. Specific properties of this RFQ are discussed and first measurements are presented.

25637 (SLAC—303, pp 282-285) **Wake field calculations with three-dimensional BCI code.** Klatt, R.; Weiland, T. (Deutsches Elektronensynchrotron DESY, Hamburg, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The new MAFIA code T3 is introduced, belonging to a family of fully 3-D codes for computer-aided design of RF cavities developed by the MAFIA collaboration at DESY, KFA Juelich and LANL. T3 is a 3-D extension of TBCI, solving Maxwell's equations in the time domain using the FIT ansatz, allowing the use of structures of arbitrary shape and dielectric material insertions, and integrating the wake potential at arbitrary positions. An open boundary condition was implemented to simulate infinite beam pipes. An IBM 3081 with 5 Mbytes of main storage can handle problems up to 80,000 mesh points while a window option enables the treatment of very long structures using up to 1,000,000 mesh points. Together with its postprocessors W3COR and W3OUT and the MAFIA mesh generator, this code was used to calculate wake potentials for several beam pipe components (i.e. vacuum chambers, vacuum chamber junctions etc.) which required fully 3-D calculations. Comparison of T3 results with TBCI calculations in the case of a cylindrically symmetric structure (pillbox) showed the agreement within a few percent.

25638 (SLAC—303, pp 296-298) **Beam transport with space charge compensation.** Klabunde, J.; Schoenlein, A. (GSI, Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

High intense ion beam pulses have been investigated in a magnetic quadrupole transport line. Due to the pulse length of 2 ms space charge compensation occurred. After a certain build-up time a saturated level of partial compensation was measured. Although the space charge forces are reduced, a considerable deterioration of beam quality was observed. In a certain parameter range of beam intensity and vacuum pressure the emittance growth was higher than it was measured with an equivalent fully space charge dominated beam. The degree of compensation was measured under different experimental conditions. The measurements will be compared with results of theoretical considerations.

25639 (SLAC—303, pp 299-301) **Project of a high-current injector at the UNILAC.** Klabunde, J.; Angert, N.; Dahl, L.; Keller, R.; Mueller, M.; Mueller, R.W.; Spaedtke, P.; Haeuser, J.; Klein, H.; Schempp, A.; Schoenlein, A. (GSI, Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

GSI is going to extend the accelerator facility by a synchrotron and an experimental storage ring over a period of four years. The UNILAC will serve as injector. In order to take advantage of the space charge limit of the synchrotron, a new injector at the UNILAC will be constructed. An increase of beam intensity by about three orders of magnitude is expected. The different sections of the new injector described.

25640 (SLAC—303, pp 308-310) **RFQ linacs with constant inner aperature and modulation.** Junior, P.; Deitinghoff, H.; Harth, A. (Institute fuer Angewandte Physik der Universitaet Frankfurt am Main, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

RFQ's are considered, where each of the four electrodes consists of an inner continuous pipe covered with a sequence of appropriate pieces of outer pipes. The acceleration rate then varies with the length of these outer sections. As a consequence of such a simple construction pattern the buncher design principles, usually based on constant phase advances, has to be abandoned. Prototypes are described and acceptance and beam currents are discussed.

25641 (SLAC—303, pp 315-317) **Beam dynamics in long transit linac cavities for heavy ion boosters.** Lapostolle, P.M.; Valero, S. (CEN Saclay, Gif-sur-Yvette, France). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A new accurate and relatively fast formalism has been derived for beam dynamics through long accelerating elements. This work was initiated by the development of heavy ion booster cavities, in particular of helix type which present no exact symmetry.

25642 (SLAC—303, pp 323-327) **Bunch shape measuring technique and its application for an ion linac tuning.** Feschenko, A.V.; Ostroumov, P.N. (Academy of Sciences of the USSR, Moscow). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A bunch shape measuring technique for an accelerated ion beam has been developed. The principle of operation is based upon the transverse rf modulation of low energy secondary emission electrons produced by ion beam passing through thin foil. A method for correct setting of phase and amplitude of the rf fields in bunchers and Alvarez tank is developed by using bunch shape measurements. Another application of developed technique is described for a longitudinal beam emittance measurements with the help of accelerating structure for a bunch rotation.

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REFER ALSO TO CITATION(S) 25709

25643 (BNL—38789) **Report of the second workshop on synchrotron radiation sources for x-ray lithography.** Barton, M.Q.; Craft, B.; Williams, G.P. (eds.). (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 52p. (CONF-8608102—Summ.). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87002155.

From Compact synchrotron X-ray source design workshop; Upton, NY, USA (25 Aug 1986).

The reported workshop is part of an effort to implement a US-based x-ray lithography program. Presentations include designs for three storage rings (one superconducting and two conventional) and an overview of a complete lithography program. The background of the effort described, the need for synchrotron radiation, and the international competition in the area are discussed briefly. The technical feasibility of x-ray lithography is discussed, and synchrotron performance specifications and construction options are given, as well as a near-term plan. It is recommended that a prototype synchrotron source be built as soon as possible, and that a research and development plan on critical technologies which could improve cost effectiveness of the synchrotron source be established. It is further recommended that a small number of second generation prototype synchrotrons be distributed to IC manufacturing centers to expedite commercialization. (LEW)

25644 (CONF-860629—70) **New concepts in microwave sources for e^-e^+ supercolliders.** Granatstein, V.L.; McAdoo, J.H.; Striffler, C.D.; Lawson, W.; Latham, P.E.; Reiser, M. (Maryland Univ., College Park (USA). Dept. of Electrical Engineering). 1986. Contract AC05-85ER40216. 4p. NTIS MF A01; 2; GPO Dep. File Number DE87006655.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The realization of e^-e^+ supercolliders will require advances in tehnology including the development of x-band microwave amplifiers with pulse energy > 60 J. Candidate microwave amplifiers include klystrons, lasertrons, free electron lasers (FEL's), and gyrotrons; gyrotron amplifiers employing a multicavity gyroklystron configuration appear advantageous at $\lambda \cong 3$ cm. Measurements on a 50 kW, 1 μs gyroklystron show phase jitter $< 0.75°$ indicating compatibility of this type of amplifier with collider requirements. The University of Maryland is currently developing an x-band, TE^0_{01} mode gyroklystron driven by 500 keV, 160 A, 2 μs electron beam pulses; combining this tube with a TE^0_{01} binary pulse compression circuit under development at SLAC could produce 475 MW, 120 ns microwave pulses which imply the feasibility of achieving linac accelerating fields in the range 100-200 MV/m.

25645 (FNAL/C—87/21) **The ACP [Advanced Computer Program] multiprocessor system at Fermilab.** Gaines, I.; Areti, H.; Atac, R.; Biel, J.; Cook, A.; Fischler, M.; Hance, R.; Husby, D.; Nash, T.; Zmuda, T. (Fermi National Accelerator Lab., Batavia, IL (USA)). 2 Feb 1987. Contract AC02-76CH03000. 9p. (CONF-870249—2). NTIS, PC A02. File Number DE87006275.

From Computing high energy physics; Pacific Grove, CA, USA (2 Feb 1987).

The Advanced Computer Program at Fermilab has developed a multiprocessor system which is easy to use and uniquely cost effective for many high energy physics problems. The system is based on single board computers which cost under $1500 each to build including 2 MBytes of on board memory. Expansion to 6 MBytes is now available. These standard VME modules each run experiment reconstruction code in Fortran at speeds approaching that of a VAX 11/780. The first system, now with 100 processors, has been operated for six months, with essentially no down time, by computer operators in the Fermilab Computer Center. An interface from Fastbus to the Branch Bus has been developed for online use which has been tested error free at 20 MBytes/sec for 48 hours. ACP hardware modules are available commercially.

25646 (LBL—22465) **Space-charge limits on the transport of ion beams in a long alternating gradient system.** Tiefenback, M.G. (Lawrence Berkeley Lab., CA (USA)). Nov 1986. Contract AC03-76SF00098. 199p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87007175.

We have experimentally studied the space-charge-dominated transport of ion beams in an alternating-gradient channel, without acceleration. We parameterize the focusing strength in terms of the zero-current "betatron" oscillation phase advance rate, σ_0 (degrees per focusing period). We have investigated the conditions for "stability", defined as the constancy of the total current and phase space area of the beam during transport. We find that the beam may be transported with neither loss of current nor growth in phase area if $\sigma_0 < 90°$. In this regime, the space-charge repulsive force can counter 98-99% of the externally applied focusing field, and the oscillation frequency of the beam particles can be depressed by self-forces to almost a factor of 10 below the zero-current value, limited only by the optical quality of our ion source. For $\sigma_0 > 90°$, we find that collective interactions bound the maintainable density of the beam, and we present a simple, semi-empirical characterization for stability, within our ability to distinguish the growth rate from zero in our apparatus. Our channel comprises 87 quadrupole lenses, 5 of which are used to prepare the beam for injection into the non-azimuthally-symmetric focusing channel.

25647 (SAND—86-1921C) **Dose-voltage dependence for HELIA/HERMES III bremsstrahlung diodes.** Sanford, T.W.L.; Halbleib, J.A.; Poukey, J.W.; Heath, C.E.; Mock, R. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 4p. (CONF-870302—11). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006698.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

The relation D α IV/sup 2.65/ is widely used to estimate the on-axis radiation dose rate, D, downstream of an optimized bremsstrahlung target as a function of diode voltage, V, for flash x-ray sources. This relation is valid only for pencil beams. For diodes having beams with finite spatial and angular extent, the power 2.65 is reduced. This reduction is evaluated via the MAGIC and CYLTRAN codes for diodes operating on the projected 20 MV HERMES III and existing 3 MV HELIA accelerators. For HERMES III, a power of 2.2 is obtained for near-field exposures using a fixed converter optimized at 20 MV. For HELIA, a power of 1.8 is obtained when the change in electron flow with voltage is also taken into account. This voltage dependence, together with the measured voltage and current waveforms on HELIA is used to calculate the expected temporal shape of the radiation pulse. The shape is consistent with that measured using a PIN diode.

25648 (SLAC—303, pp 330-332) **OSCAR2D, a computer code for the design of RF cavities and structures.** Fernandes, P.; Parodi, R. (IMA, Genoa, Italy). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The OSCAR2D code for computation of field and frequencies of resonant cavities and structures is presented. The code is mainly oriented to the computation of RF fields, of cavities and structures, with high precision in order to use the computed fields for simulation of electric vacuum discharges (resonant or not) close to the cavity boundary. The NEWTRAJ post processor allows for the computation of electron trajectories on monopolar TM modes of the RF structures, taking into account the multiplication of electrons due to secondary emission and back-scattering.

25649 (SLAC—303, pp 346-348) **RFQ scaling law implications and examples.** Wadlinger, E.A. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The utility of RFQ scaling laws are demonstrated. These laws are relations between accelerator parameters (electric field, rf frequency, etc.) and beam parameters (current, energy, emittance, etc.) that act as guides for designing radio-frequency quadrupoles (RFQs) by showing the various traditional tradeoffs involved in making RFQ designs. These scaling laws give a unique family of curves, at any given synchronous particle phase, that relates the beam current, emittance, particle mass, and space-charge tune depression with the RFQ frequency and maximum vane-tip electric field when assuming equipartitioning and equal longitudinal and transverse tune depressions. These scaling curves are valid at any point in any given RFQ where there is a bunched and equipartitioned beam. Several examples are shown for designing RFQs, the performance characteristics of an existing device, and various RFQ performance limitations required by the scaling laws are examined.

25650 (SLAC—303, pp 352-354) **New high intensity DC H^- ion source for TRIUMF.** Baartman, R.; Kendall, K.R.; McDonald, M.; Mosscrop, D.R.; Schmor, P.W.; Yuan, D. (TRIUMF, Vancouver, British Columbia). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A dc volume H^- source, employing multicusp plasma confinement, which has been constructed for use with the TRIUMF cyclotron is described. An extracted H^- current density of 12 mA/cm^2 has been obtained. Beam emittance and brightness have been measured as a function of current density and beam fraction. Beam brightness values for normalized beam emittance at 81% beam fraction are typically 10 mA/(mm x mrad)^2 (equivalent rms B = 200 mA/(mm x mrad)^2). A 9.4 m long beam line containing only electrostatic optics is being built to transport up to 2 mA of H^- beam at 300 keV from the ion source into the existing cyclotron injection beam line.

25651 (SLAC—303, pp 258-260) **Operation of a short pulse negative ion source.** Hill, C.E. (CERN, Geneva, Switzerland). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A magnetically filtered multicusp negative hydrogen ion source has been tested on the RFQ-1 preinjector at CERN in anticipation of injection of H^- beams into the LEAR machine. Although the source is remarkably simple in concept, its operation in the short pulse mode ($> 10\ \mu s$) has proved to be somewhat more complicated due to a long formation time of the negative ions. For a 150 μs long discharge of 230 A, a maximum of 5 mA of H^- has been accelerated to 520 keV in unoptimized conditions.

25652 (SLAC—303, pp 374-376) **Multi-module cavity structure of split coaxial RFQ.** Tojyo, E.; Arai, S.; Fujino, T.; Fukushima, T.; Tokuda, N.; Hattori, T. (Univ. of Tokyo, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

In the development of a split coaxial RFQ with modulated vanes, a multi-module cavity structure has been used to achieve the easy alignment of vanes and the mechanical stability of the structure. The rf characteristics of the structure such as the effects of the stems and electrode shape on the resonant frequency are examined by using a 1/4 scaled model with flat vanes. The results of experiments are compared with calculations. The proton acceleration test is in preparation, where the 1/4 scaled model is used by replacing the flat vanes by the modulated vanes.

25653 (SLAC—303, pp 407-410) **Magnet innovations for linacs.** Halbach, K. (Lawrence Berkeley Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

It is possible to produce large magnetic fields at the aperture of permanent magnet quadrupoles, even when the magnetic aperture is very small. That, combined with their compactness, makes permanent magnet quadrupoles very powerful components of small aperture linacs. Results of past and present work on both fixed and variable strength permanent magnets suitable for use in and around linacs are presented.

25654 (SLAC—303, pp 411-415) **Electron linac injector developments.** Fraser, J.S. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

There is a continuing demand for improved injectors for electron linacs. Free-electron laser (FEL) oscillators require pulse trains of high brightness and, in some applications, high average power at the same time. Wakefield-accelerator and laser-acceleration experiments require isolated bunches of high peak brightness. Experiments with alkali-halide photoemissive and thermionic electron sources in rf cavities for injector applications are described. For isolated pulses, metal photocathodes (illuminated by intense laser pulses) are being employed. Reduced emittance growth in high-peak-current electron injectors may be achieved by linearizing the cavity electric field's radial component and by using high field strengths at the expense of lower shunt impedance. Harmonically excited cavities have been proposed for enlarging the phase acceptance of linac cavities and thereby reducing the energy spread produced in the acceleration process. Operation of injector linacs at a subharmonic of the main linac frequency is also proposed for enlarging the phase acceptance.

25655 (SLAC—303, pp 416-420) **Linacs for microtrons and pulse stretchers.** Penner, S. (National Bureau of Standards, Gaithersburg, MD). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

For many applications, continuous (CW) beams of electrons are strongly preferred over the low duty cycle beams available for RF linacs. The two preferred methods for realizing high-energy CW beams are (1) a pulsed linac followed by a pulse-stretcher ring, and (2) a recirculating CW accelerator. In both methods, a high performance electron linac is required. Recent advances in the technology and understanding of standing wave structures appear to make them preferable to travelling wave linacs for the pulse-stretcher method. Recirculating linacs, whether of the racetrack microtron type or some other topology, are built with CW standing wave linacs. Both room temperature and superconducting structures have been used. Recent exciting advances in superconducting structures make them the structures of choice for high energy CW electron accelerators.

25656 (SLAC—303, pp 437-446) **High-field capture section for SLC positron source.** Hoag, H.A.; Deruyter, H.; Kramer, J.; Yao, C.G. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The positron source for SLC is being installed at the two-thirds point on the SLAC linac. Electron bunches at 33 GeV impinge upon a tantalum/tungsten target, producing showers of positrons with energies extending from approximately 2 to 20 MeV, with most positrons at the law end of this range. Positrons with low energies and finite transverse momenta slip phase during the processes of reacceleration and reinjection into the SLC system, increasing the energy spread and reducing the overall yield of the positron source. This reduction in yield has to be minimized by capturing the positrons with a high-field accelerator section placed as soon after the target as possible. The design, fabrication and RF testing of this accelerator section is discussed.

25657 (SLAC—303, pp 444-448) **Industrial development of Cornell superconducting cavities for CEBAF.** Bensiek, W.; Garner, G.; Hager, J.; Biallas, G.; Chargin, A.; Moss, B.; Parkinson, J.; Amato, J.; Brawley, J.; Coulombe, D.; Morse, D. (Babcock and Wilcox, Lynchburg, VA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Properties of the Cornell five-cell superconducting accelerating cavity and the suitability of this cavity for the CEBAF linac are discussed. The advanced technology required to produce these cavities was already known to some companies and is being transferred to others. The status of development of these cavities by industry, including test results on three of these cavities, is discussed.

25658 (SLAC—303, pp 458-460) **Voltage breakdown at X-band and C-band frequencies.** Tanabe, E.; Wang, J.W.; Loew, G.A. (Varian Associates, Inc., Palo Alto, CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Economy of length and electric power in the design of future linear accelerators requires a knowledge of the electric field breakdown limits in RF structures as a function of frequency. The limits predicted by the Kilpatrick breakdown criterion, which gives a law of maximum surface electric field increasing with frequency, have already been exceeded at frequencies under 1 GHz and S-band (3 GHz). The work described explores these limits at 5 and 9 GHz in single cavities. Experimental setups, procedures and results are presented.

25659 (SLAC—303, pp 481-483) **Phase control system of the KEK 2.5 GeV electron linac.** Hanaki, H.; Otake, Y.; Saito, Y.; Ohsawa, S.; Anami, S.; Tanaka, J. (National Lab. for High Energy Physics, KEK, Ibaraki-ken, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The automatic control system was developed for the phasing of 41 klystrons in the KEK linac. The method of phasing is based on the phase comparison between the beam induced wave and the acceleration wave. The phase detector was newly developed and composed of a precise hybrid power divider and a well-balanced pair of diodes. The phase detection error at a null output signal is kept within +/-0.5° over a 30 dB range of the input power. The phasing unit has a single board computer to realize intelligent functions, so that the phasing procedure can be carried out automatically in response to a request from the control room through the communication loops. The 5 phasing units were installed in the 5 sub-control rooms, respectively, and each unit controls 8 or 9 phase shifters for klystrons. As a result of the auto-phasing, easy operation of the phasing system has been achieved and the adjusting time was reduced to about a half of that for the manual procedure.

25660 (SLAC—303, pp 487-489) **Electron gun for the positron generator.** Fukuda, S.; Ogawa, Y.; Saito, Y.; Otake, Y.; Ohsawa, S.; Anami, S.; Shidara, T.; Kaneko, N.; Asami, A.; Tanaka, J. (National Lab. for High Energy Physics (KEK), Ibaraki-ken, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A triode electron gun has been installed on the Positron Generator at KEK, and brought into test operation. It involves a grid-cathode assembly currently used in a planner triode. The cathode has a diameter of 10 mm and is coated with Ba-Sr-Ca oxide. Because of the short grid-cathode distance (0.18 mm), the relatively low grid pulse voltages makes it possible to draw a high current. The assembly has a small vacuum flange which allows its easy replacement. Emission current from the oxide cathode is sensitive to residual gases, therefore, the vacuum system is carefully made and the pressure is kept in the range of 10^{-9} Torr even when the accelerator is on. The grid pulser is a line type pulser using multi-stage avalanche transistors as a switch. The pulse width of 10 nsec has been used for the test to investigate the gun characteristics. The performance of the gun has been tested with this pulser and the emission current of 9.7 A was achieved at an injection voltage of 110 kV. The characteristics of the gun are described together with the beam trace.

25661 (SLAC—303, pp 496-498) **Injector of the positron generator.** Asami, A.; Ogawa, Y.; Ohsawa, S.; Anami, S.; Fukuda, S.; Enomoto, A.; Kaneko, N.; Otake, Y.; Saito, Y.; Shidara, T.; Abe, I. (National Lab. for High Energy Physics (KEK), Ibaraki-ken, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Main components of the Positron Generator injector are briefly described, which include an electron gun, a subharmonic buncher (SHB), a prebuncher and a buncher, an rf waveguide, a transport and a vacuum system, etc. The vacuum system around the gun was carefully made to obtain a high emission current. The SHB was introduced to increase the peak current and operates at 119 MHz, the 24th subharmonic frequency. Performance of the injector has been tested yielding the results that about 60% of the injected current from the gun is successfully accelerated without the SHB. An injection current obtained is typically 7 A for 5 nsec pulse. For 3 nsec (FWHM) beam the accelerated electron and the positron beams are increased by a factor of 1.5 with the SHB.

25662 (SLAC—303, pp 499-501) **Accelerator guide of positron generator linac.** Sato, I.; Matsumoto, K.; Enomoto, A.; Oogoe, T.; Kakihara, K.; Tanaka, J.; Yamaguchi, N.; Iino, Y.; Taki, K.; Inoue, K. (National Lab. for High Energy Physics, Ibaraki-ken, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A positron generator linac was constructed for the purpose of supplying a positron beam to TRISTAN. This linac facility consists of an electron linac and a positron linac. The former is composed of a subharmonic buncher, a prebuncher, a buncher, a regular accelerator guide and an electric gun. Latter is composed of a regular accelerator guide. Two kinds of accelerator guides having a different length; a 2 m and a 4 m accelerator guides are developed for the positron linac. A structure, production, and the characteristics of these accelerator guides are described.

25663 (SLAC—303, pp 502-504) **Acceleration characteristics of positron generator linac.** Sato, I.; Matsumoto, H.; Enomoto, A.; Oogoe, T.; Kakihara, K.; Anami, S.; Fukuda, T.; Shidara, T.; Saito, Y.; Hanaki, H.; Matsuda, N. (National Lab., for High Energy Physics, Ibaraki-ken, Japan). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The positron generator linac was planned for the purpose of supplying a positron beam to TRISTAN-RING. This plan was proposed in FY 1977. This proposal was authorized and carried out for 3 years from FY 1982. Construction of this linac facility began in April 1982 and completed in March 1985. The first operation began on April 1985. After three months, the positron generator linac succeed in a first acceleration of a positron beam. In March of this year, the positron beam and the electron beam were alternatively transported to a accumulator ring of TRISTAN, there succeeded in a first collision of those beams. The operation and acceleration characteristics are discussed.

25664 (SLAC—303, pp 508-511) **Experiences in fabricating and testing the RF-sections of the Mainz Microtron.** Euteneuer, H.; Schoeler, H. (Institut fuer Kernphysik, Mainz, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

For the 840 MeV-setup of the Mainz Microtron cascade (MAMI B) the fabrication of a total of 10 rf-sections is under way. Based on the experience with the 6m structure built in-house for the 14 MeV- and 180 MeV-stages of MAMI, an optimized final design, and an as far as possible simplified fabrication and testing procedure, for these medium power on-axis-coupled structures has evolved. The standard 29-cavity-structures are described with their simple cooling arrangement and the tuning plungers placed at the ends of the section. Some details for machining high-Q, high precision cavity segments and tuning and brazing them are given. Finally, results from the test-procedure of the sections up to a power of 22KW/m (1.2 MV/m) are reported: optimum conditioning, changes of the passband gap (permanent and with power) and observations done by residual gas analyzer as well as by just looking into the structures under power.

25665 (SLAC—303, pp 523-525) **Field computations and measurements on a biperiodic buncher structure.** Fernandes, P.; Parodi, R.; Spataro, B.; Tazzioli, F.; Tronc, D. (IMA-CNR, Genoa, Italy). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A biperiodic bunching section of new design was built for upgrading the Frascati S band Linac. The parameters of the structure were determined by computation with the OSCAR-2d code and checked by measurements on models.

25666 (SLAC—303, pp 531-533) **Frequency scaling of linear super-colliders.** Mondelli, A.; Chernin, D.; Drobot, A.; Reiser, M.; Granatstein, V. (Science Applications International Corp., McLean, VA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC05-85ER40216.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The development of electron-positron linear colliders in the TeV energy range will be facilitated by the development of high-power rf sources at frequencies above 2856 MHz. Present S-band technology, represented by the SLC would require a length in excess of 50 km per linac to accelerate particles to energies above 1 TeV. By raising the rf driving frequency, the rf breakdown limit is increased, thereby allowing the length of the accelerators to be reduced. Currently available rf power sources set the realizable gradient limit in an rf linac at frequencies above S-band. A model for the frequency scaling of linear colliders is presented, with luminosity scaled in proportion to the square of the center-of-mass energy. Since Wakefield effects are the dominant deleterious effect, a separate single-bunch simulation model is described which calculates the evolution of the beam bunch with specified Wakefields, including the effects of using programmed phase positioning and Landau damping. The results presented have been obtained for a SLAC structure, scaled in proportion to wavelength.

25667 (SLAC—303, pp 46-47) **Thermal design of drift tubes for high-gradient linacs.** Liska, D.J.; Bultman, N.; Carlisle, L.O. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

High-intensity drift tube linacs were designed at Los Alamos using copper drift tubes capable of very high duty-factor operation, limited only by beam-loss heating in the bore. The drift-tube bodies are cooled by a peripheral, full-length cooling jacket that effectively clamps the drift tube at the average coolant temperature and shields the samarium-cobalt quadrupole from excessive heating caused by rf dissipation. The bore tube is thick-walled copper that is split to provide a gap for thermal-expansion, beam-diagnostic instrumentation, and vacuum relief of the drift-tube body. The magnet pole pieces are isolated from the bore tube by a 0.2-mm thermal gap that is very effective in preventing beam-loss heating from degrading the magnetic properties of the quadrupoles. The authors discuss thermal studies that explore the capabilities of this design concept. The design features of the quadrupoles include a technique for precision shimming using captive screws and guide slots. Results of tests on prototype quadrupole assemblies are presented.

25668 (SLAC—303, pp 48-49) **Precision alignment of permanent magnet drift tubes.** Liska, D.J.; Dauelsberg, L.B.; Spalek, G. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The Lawrence Berkeley National Laboratory (LBNL) technique of drift-tube alignment has been resurrected at Los Alamos for the precision alignment of 1-cm-core drift tubes that carry high gradient rare-earth-cobalt quadrupoles. Because the quadrupoles cannot be switched off, this technique is not applicable to a drift-tube assembly, but tests indicate that individual magnetic centers can be detected with a precision of +/-0.003 mm. Methods of transferring this information to machined alignment flats on the sides of the drift-tube body are discussed. With measurements of drift tubes designed for a 100-mA, 425-MHz drift-tube linac, offsets between the geometric and magnetic axes of up to +/-0.05 mm were detected following final assembly and welding. This degree of offset is serious if not accommodated, because it represents the entire alignment tolerance for the 40-cell tank. The measurement equipment and technique are described.

25669 (SLAC—303, pp 53-55) **Rf power amplifier with dedicated interlock and feedback controller.** Mitra, A.K.; Sauer, M.; Janssen, W. (Kernforschungsanlage Juelich, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A 100 MHz 1 MW pulsed rf amplifier chain with its local control system capable of fulfilling all necessary remote functions as well as phase and amplitude feedback is described. The high power rf amplifier as a self-contained unit incorporating power supplies, cooling, modulation units and dedicated processors has been used to power up an accelerating structure namely RFQ. A Siemens Microprocessor System (SMP) with Mitsubishi PC backup is employed for setting up the dc operating point of the amplifier and monitoring the status of the same. Amplifier diagnostic and test routines are also installed through software packages. Finally, to achieve maximum personal and machine safety several interlocks and control levels are defined and discussed.

25670 (SLAC—303, pp 56-58) **Non-destructive beam monitors for the SNQ-Linac.** van der Hart, A.; Schmidt, F.; Kennepohl, K.; Bongardt, K.; Uhlemann, R.; Kennepohl, C.; Zwoll, K. Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Non-destructive beam diagnostics are an important feature for high-current ion beams. Details of the diagnostic prototypes originally conceived for the 200 mA SNQ linac are presented. The residual gas monitor for the low energy beam line consists of a commercial one-dimensional photo diode-array camera (1728 elements), with optional picture amplifier, connected to a microprocessor system for fast data acquisition. With this device, an integration time of 250 μsec and a data processing time of 20 msec were achieved. First results are reported from beam tests done at SIN Zuerich. For determining the bunch length, a facility for testing a 200 MHz broad band capacitive button type pick up ws built. The transfer function for geometrical different kind of pick ups was measured and compared with simple analytical expressions. By applying the complex Fourier transformation technique the 200MHz input beam pulse could be reconstructed with quite high accuracy.

25671 (SLAC—303, pp 59-61) **Control of linear accelerator noise in the Los Alamos free-electron laser (FEL).** Lynch, M.T. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

FELs require tight control of the amplitudes and phase of the fields in two linear accelerator tanks to obtain stable lasing. The accelerator control loops must establish constant, stable, repeatable amplitudes and phases of the rf fields and must have excellent bandwidth to control high-frequency noise components. A model of the feedback loops has been developed that agrees well with measurements and allows easy substitution of components and circuits, thus reducing breadboarding requirements. The model permits both frequency and time-domain analysis. The accelerator control scheme and model are described and the control of noise in feedback loops is discussed, showing how low-frequency-noise components (errors) can be corrected, but high-frequency-noise components (errors) are actually amplified by the feedback circuit. Measurements of noise in both open- and closed-loop modes is shown and comparison is made with results from the model calculations.

25672 (SLAC—303, pp 70-72) **Rf drive system for the CEBAF superconducting cavities.** Fugitt, J.A.; Moore, T.L. (Continuous Electron Beam Accelerator Facility (CEBAF), Newport News, VA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

To obtain the maximum accelerating gradient, the CEBAF RF system uses an individually controlled RF drive chain for each superconducting cavity. This allows one to adjust each cavity to its individual maximum field. Due to material purity and manufacturing tolerances of the cavities, it is expected that this maximum value will be distributed over an almost 2 to 1 gradient range. The requirement for precise individual phase and gradient control of 420 superconducting accelerating cavities, is accomplished through the use of individual fault tolerant RF drive chains and self monitoring control electronics. This might be thought of as the Phased Array approach to accelerator RF systems.

25673 (SLAC—303, pp 73-75) **CEBAF cavity cryostat.** Biallas, G.; Brindza, P.; Phillips, H.L.; Kirchgessner, J. (Continuous Electron Beam Accelerator Facility, Newport News, VA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The modular design of the linac cryostat system based on a cavity-pair is presented. Description of the cryogenic module consisting of four cavity-pairs is included. The methods of making a cavity-pair hermetic during cryostat assembly, introducing the waveguides, supporting the helium vessels and introducing instrumentation are presented. Also, included are the methods of tuning the cavities, aligning them to exterior references and connecting cryogenic fluid circuits to adjacent modules and transfer lines.

25674 (SLAC—303, pp 76-80) **CEBAF cryogenic system.** Brindza, P.; Rode, C. (Continuous Electron Beam Accelerator Facility, Newport News, VA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The Continuous Electron Beam Accelerator Facility (CEBAF) is a standing wave superconducting linear accelerator with a maximum energy of 4 GeV and 200 μA beam current. The 418 Cornell/CEBAF superconducting niobium accelerating cavities are arranged in two 0.5 GeV linacs with magnetic recirculating arcs at each end. These accelerating cavities are arranged in pairs in a cryounit. The ensemble of four cryounits (8 cavities) together with their end caps makes up a complete cryostat called a cryogenic module. The four cryounit helium vessels are cross connected to each other and share a common cryogen supply, radiation shield and insulating vacuum. The cryogenics system for CEBAF consists of a 5kW central helium refrigerator and a transfer line system to supply 2.2 K 2.8 ATM helium to the cavity cryostats, 40 K helium at 3.5 ATM to the radiation shields and 4.5K helium at 2.8 ATM to the superconducting magnetic spectrometers in the experimental halls. Both the 2.2 K and the 4.5 K helium are expanded by Joule-Thompson (JT) valves in the individual cryostats yielding 2.0 K at .031 ATM and 4.4 K at 1.2 ATM respectively. The Central Helium Refrigerator is located in the center of the CEBAF racetrack with the transfer lines located in the linac tunnels.

25675 (SLAC—303, pp 134-137) **Polarized H^- source development at BNL.** Alessi, J.G.; Hershcovitch, A.; Kponou, A.; Niinikoski, T.; Sluyters, Th. (Brookhaven National Lab., Upton, NY). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The AGS polarized H^- source (PONI-1) now produces currents of 25-40 μA, and has operated reliably during polarized physic runs. A new polarized source, having as its goal mA's of H, is now under development. An atomic hydrogen beam has been cooled to about 20 K with a forward flux of $\lambda 10^{19}$ atoms/s/sr. A superconducting solenoid having a calculated acceptance angle of 0.1 sr for the cold H^0 beam, is now being built. An ionizer for the resulting polarized H^0 beam based on resonant charge exchange of H^0 with D^-, is being tested. 500 $^+$A of H^- have been produced by ionizing an unpolarized H^0 beam using this ionizer.

25676 (SLAC—303, pp 138-140) **Factors affecting H√ beams performance in the Fermilab linac.** Curtis, C.D.; Owen, C.W.; Schmidt, C.W. (Fermi National Accelerator Lab., Batavia, IL). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Addition of an independently controlled heater and a grooved cathode to the magnetron ion source has significantly improved source lifetime and consistency of performance at the 50-mA beam level. Emittance measurements at 750 keV and 200 MeV are shown with comparisons between flat and grooved cathode sources and for variations of other conditions. The dramatic effect of beam space charge is shown in comparison with neutralized beams. Some variation of linac emittance with linac quadrupole tuning is explored.

25677 (SLAC—303, pp 157-159) **Coherent very high power microwave source using a virtual cathode oscillator.** Fazio, M.V.; Hoeberling, R.F. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

An oscillating virtual cathode produced by a multikiloampere relativistic electron beam can generate microwave power at levels from several-hundred megawatts to one gigawatt. This type of source can operate from 500 MHz to 40 GHz. To become useful as an accelerator driver, it is essential that the frequency and phase of the microwave radiation be controlled. To accomplish this, it may be possible to use the resonant interaction between the oscillating virtual cathode and a microwave cavity that is pumped with a klystron-injected signal to produce a microwave source capable of very high power, narrow bandwidth, narrow-band frequency tunability, and phase controlability.

25678 (SLAC—303, pp 163-165) **New concepts in microwave sources for e^-e^+ supercolliders.** Granatstein, V.L.; McAdoo, J.H.; Striffler, C.D.; Lawson, W.; Latham, P.E.; Reiser, M. (Univ. of Maryland, College Park). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

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The realization of e^-e^+ supercolliders will require advances in technology including the development of X-band microwave amplifiers with pulse energy > 60 J. Candidate microwave amplifiers include klystrons, lasertrons, free electron lasers (FEL's), and gyrotrons; gyrotron amplifiers employing a multicavity gyroklystron configurations appear advantageous at $\lambda = 3$ cm. Measurements on a 50 kW, 1 μs gyroklystron show show phase jitter $< 0.75^0$ indicating compatibility of this type of amplifier with collider requirements. The University of Maryland is currently developing an X-band, $TE_{01}{}^0$ mode gyroklystron driven by 500 keV, 160 A, 2 μs electron beam pulses; combining this tube with a $TE_{01}{}^0$ binary pulse compression circuit under development at SLAC could produce 475 MW, 120 ns microwave pulses which imply the feasibility of achieving linac accelerating fields in the range 100-200 MV/m.

25679 (SLAC—303, pp 166-168) **High peak power, X-band gyroklystron for linear accelerators.** Lawson, W.; Calame, J.; Granatstein, V.L.; Latham, P.E.; Park, G.S.; Reiser, M.; Striffler, C.D.; Williams, F.J. (Univ. of Maryland, College Park). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The gyrotron mechanism, which generates coherent radiation at the electron cyclotron frequency, facilitates the use of overmoded cavities and is believed to have excellent potential for development into the high peak power, high gain, efficient amplifier required for a high energy linear accelerator. A 30 MW, 1-2 μs, 10 GHz gyroklystron that is currently under development at the University of Maryland is described. The 30 MW power level represents an enhancement of almost three orders of magnitude over the current state-of-the-art in gyroklystrons. This enhancement will be achieved by utilizing large beam energies and moderately overmoded cavities ($TE_{01}{}^0$). Recent progress is presented on the design and construction of all the major subsystems, including the modulator, the Magnetron Injection Gun used to generate a 500 keV, 160 A annular beam, the magnet system, and the gyrotron circuit predicted to achieve conversion efficiencies in the 30%-42% range.

25680 (SLAC—303, pp 188-193) **Recent developments in rf superconductivity for linac structures.** Lengeler, H. (CERN, Geneva, Switzerland). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The status of superconducting linear accelerators for heavy ions and for electrons is reviewed. New types of cavities for heavy ion acceleration have been developed and fields of 3-4 MB/m can be reached routinely. They will extend the velocity range towards lower and higher values and allow new applications. Multicell cavities for electron acceleration now reach field levels of 5-10 MV/m and Q_0 values of a few 10^9 in a reliable way and regular production by industry can be envisaged. Latest results obtained with Nb-coated Cu-cavities and with Nb_3SN cavities are given. Some new developments for cryostats, tuners and couplers are described.

25681 (SLAC—303, pp 194-199) **CEBAF superconducting accelerator: an overview.** Leemann, C.W. (Continuous Electron Beam Accelerator Facility, Newport News, VA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The CEBAF accelerator is a CW linac based on RF superconductivity and making use of multiple recirculation. Its major components are a 50 MeV injector, two linac segments of 0.5 GeV energy gain each, and recirculator arcs connecting the two linac segments. Each linac segment consists of 25 cryomodules, separated by warm sections with quadrupoles, steering magnets, and beam diagnostics. Each cryomodule contains 8, 1500 MHz, 5-cell, Cornell type cavities with waveguide couplers for fundamental power and HOM damping, each cavity being powered by its own klystron. Recirculator arcs are vertically stacked, large radius, strong focusing beam lines that minimize synchrotron radiation effects. A high quality ($\Delta E/E \sim 10^{-4}$, epsilon $\sim 10^{-9}$ m) beam of 200-A, 100% duty factor, with 0.5 GeV $\leqq E \leqq$ 4.0 GeV will be generated.

25682 (SLAC—303, pp 232-236) **Innovations in ion sources and injectors.** Keller, R. (GSI, Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Current trends in the development of high-intensity positive-ion sources for linear accelerators are discussed with regard to particle production, ionization principle, and extraction system. A few sources are presented and their most recent beam data given. The performance of injection systems under the influence of strong space-charge action is demonstrated in an example. The design of a compounds system where the beam is extracted, focused, and accelerated to injection energy in a single structure with reduced aberration is explained in the following. In connection with this system the concept of beam emittance is critically examined and a new interpretation of fractional emittances derived.

25683 (SLAC—303, pp 237-242) **Progress in the development of H^- ion sources.** Prelec, K. (Brookhaven National Lab., Upton, NY). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Charge state of an H^- ions can be changed easily by either single (neutralization) or double (ionization) electron stripping, in a very wide energy range. Development of H^- ion sources has been stimulated by several areas of application: production of high power beams of hydrogen atoms with energies of several hundred keV for plasma heating and current drive in fusion devices, production of high brightness beams of hydrogen atoms in the energy range around 100 MeV, and for use in some accelerators where H^- ions facilitate and improve the injection or ejection processes. This paper will put most emphasis on the accelerator application. Two types of sources will be considered, those where H^- ions are produced in processes on a low work function surface and those where they are produced in collisions occurring in the plasma. After a short outline of theoretical work and experimental studies of relevant processes and phenomena, a review of existing source designs will be given, describing their performance.

25684 (SLAC—303, pp 260-262) **Design of an RFQ-based, H^- injector for the BNL/FNAL 200 MeV proton linacs.** Gough, R.A.; Staples, J.; Tanabe, J.; Yee, D.; Howard, D.; Curtis, C.; Prelac, K. (Lawrence Berkeley Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC03-76SF00098.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

An LBL/BNL/FNAL collaboration has been formed to design an RFQ-base Cockcroft-Walton replacement, suitable for use at the Brookhaven and Fermilab 200 MeV proton linacs. A common design for the ion source and the RFQ will result in an economical construction and testing program compatible with both applications. The technical requirements have been evaluated and it appears that they can be satisfied with identical RFQs, capable of accelerating 50 mA of H^- from 35 to 750 keV, at a normal frequency of 200 MHz.

25685 (SLAC—303, pp 263-265) **SuperHILAC upgrade project.** Feinberg, B.; Brown, I.G. (Lawrence Berkeley Lab., CA). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract AC03-76SF00098.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

A high current Metal Vapor Vacuum Arc (MEVVA) ion source[1] is to be installed in the third injector (Abel) at the SuperHILAC, representing the first accelerator use of this novel ion source. The MEVVA source has produced over 1 A of uranium in all charge states, with typically more than 100 electrical mA (emA) of U^{5+}. A substantial fraction of this high current, heavy ion beam must be successfully transported to the entrance of the Wideroe linac to approach the 10 emA space-charge output limit of the Wideroe. Calculations show that up to 50 emA of U^{5+} can be transported through the present high voltage column. A bouncer will be added to the cockcroft-Walton supply to handle the increased beam current. The Low Energy Beam Transport line vacuum will be improved to reduce charge exchange, and the phase matching between the 23 MHz Wideroe and the 70 MHz Alvarez linacs will be improved by the addition of two 70 MHz bunchers. The installation of the MEVVA source along with the modifications described above are expected to result in a five-fold increase in beam delivered to Bevatron experiments, increasing the extracted uranium beam to 5 x 10^7 ions/pulse.

25686 (SLAC—303, pp 266-268) **Status of the positive-ion injector for ATLAS.** Bollinger, L.M.; Pardo, R.C.; Shepard, K.W. (Argonne National Lab., IL). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—). Contract W-31-109-ENG-38.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The planned positive-ion injector for ATLAS consists of an ECR ion source on a 350-kV platform and a superconducting injector linac of a new kind. The objective is to replace the present tandem injector with a system that can increase beam intensities by two orders of magnitude and extend the mass range up to uranium. In the first, developmental stage of the work, now in progress, the ECR source will be built, the technology of superconducting accelerating structures for low-velocity ions will be developed, and these structures will be used to form a 3-MV prototype injector linac. Even this small system, designed for ions with $A < 130$, will be superior to the present FN tandem as a heavy-ion injector. In later phases of the work, the injector will be enlarged enough to allow ATLAS to effectively accelerate uranium ions. The injector system is expected to provide exceptional beam quality. The status of the work, expected performance of the accelerator systems, and the technical issues involved are summarized.

25687 (SLAC—303, pp 272-275) **Microwave undulator.** Batchelor, K. (Brookhaven National Lab., Upton, NY). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

At the present time the use of static magnetic field has been the dominant method by which undulator synchrotron radiation has been produced. A microwave undulator utilizing a plane rectangular waveguide operating in the TE/sub 10n/ mode presents a possible alternate means of producing this synchrotron radiation. Also, since a typical resonator may be many guide wavelengths in length it is possible to make the undulator source tunable over a broad spectral range.

25688 (SLAC—303, pp 276-278) **MAFIA - a three-dimensional electromagnetic CAD system for magnets, RF structures, and transient wake-field calculations.** Klatt, R.; Krawczyk, F.; Novender, W.R.; Palm, C.; Weiland, T.; Steffen, B.; Barts, T.; Browman, M.J.; Cooper, R.; Mottershead, C.T.; Rodenz, G.; Wipf, S.G. (Deutsches Elektronen-synchrotron DESY, Hamburg, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The acronym MAFIA stands for the solution of Maxwell's equations by the finite integration algorithm, and is the name given to a set of codes intended for use in the computer-aided design of three-dimensional magnets, rf structures, and structures in which wake-field effects are important. The interconnection of the various codes in the MAFIA collection are shown. M3 is the mesh generator used by all the MAFIA codes, T3 is the wake-field code, R3 generates the matrix whose eigenvalues and eigenvectors yield the frequencies and electric field components, receptively, of the normal modes of electromagnetic oscillations of an rf structure, E3 is the eigenvalue solver, and P3 is the postprocessor that calculates the quantities of physical interest, such as shunt impedance, quality factor, deflection integrals, etc. The code S3, now being written will solve electro- and magnetostatic problems. The collection of programs M3, R3, E3, and P3 are also known as URMEL-3D. A description of the FIT method is given, followed by brief descriptions of the codes M3, R3, E3, and P3. Finally, how one can get and use these codes are discussed.

25689 (SLAC—303, pp 279-281) **Three-dimensional cavity calculations.** Browman, M.J.; Cooper, R.; Weiland, T. (Los Alamos National Lab., NM). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The existence of a code that solves for the resonant electromagnetic modes of oscillation in arbitrarily-shaped three-dimensional cavities opens new possibilities in rf-structure analysis and research. The URMEL-3D code, the product of a multi-year collaboration between DESY, KFA-Juelich, and Los Alamos, has been used in some exploratory studies to determine the feasibility of using a 3-D code to calculate the properties of several practical rf structures. The results are reported here for three cases: the jungle gym, two coupled cavities, and a waveguide-cavity coupling problem.

25690 (SLAC—303, pp 286-288) **Cavity and waveguide design by triangular mesh code UREML-T.** van Rienen, U.; Weiland, T. (Deutches Elektronensynchrotron DESY, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Computer codes are increasingly essential for the design of RF accelerating cavities and waveguides. The code URMEL-T uses a triangular mesh and the FIT discretization method, a finite difference method. Going beyond the capability of the most highly developed codes, URMEL-T deals with cavities of cylindrical or translationally invariant symmetry and waveguides - each with arbitrary dielectric and/or permeable material insertions. The theory underlying the code transforms Maxwells' equations via difference equations into a linear algebraic eigenvalue problem which has to be solved for only a small number of lowest eigenvalues. The solution provides fields, eigenfrequencies (propagation constants for waveguides) and the usual quality factors, voltages and other shunt impedance-related quantities.

25691 (SLAC—303, pp 289-291) **Impedance of cavities with beam ports above cut-off.** van Rienen, U.; Weiland, T. (Deutches Elektronensynchrotron DESY, Hamburg, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

Accelerating cavities made out of perfect conducting metal have only a finite number of resonant modes due to the (necessary) beam ports. Above the lowest cut-off frequency of the travelling modes in the beam pipe no undamped resonance can exist. Thus the impedance in this range of frequency cannot be obtained by resonator codes such as URMEL. The continuous impedance above cutoff for cavities of arbitrary shape but cylindrical symmetry can be calculated by exciting the cavity with a beam current equal to the Fourier transform of a point charge traversing the structure. Solving Maxwells equations for the fields yields the longitudinal electric field and thus by integration the impedance. URMEL has been extended to enable such calculations by setting up an inhomogeneous, complex matrix equation for a given frequency. Solving for that complex system of linear equations yields the electromagnetic field and thus the complex impedance.

25692 (SLAC—303, pp 292-295) **Modes in infinitely repeating structures of cylindrical symmetry.** Weiland, T. (Deutsches Elektronensynchrotron DESY, Hamburg, West Germany). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

The computer code URMEL for calculating modes in arbitrarily shaped cavities of cylindrical symmetry has been extended to the case of infinitely repeating periodic structures. This extension now offers a simple way for evaluating the group velocity in long linac structures. URMEL now also calculated for a given phase advance over one period the resonant frequencies and fields for the m lowest modes ($m = 100$, say). Thus a much higher accuracy can be obtained compared to multi-cell computations where one has to solve for n cells in order to obtain $n + 1$ values of the dispersion curve. This new option has been implemented in URMEL (release 5) as a new boundary condition plus a new input variable for the phase advance.

25693 (SLAC—303, pp 318-322) **RF linac for heavy ion fusion driver.** Kapchinskiy, I.M.; Kuschin, V.V.; Lazarev, N.V.; Schevchenko, V.G.; Artemov, V.S.; Batalin, V.A.; Daniltzev, E.N.; Djadin, A.Ju.; Iosseliani, D.D.; Kozodaev, A.M.; Kurs, A.R. (Institute for Theoretical and Experimental Physics, Moscow, USSR). Sep 1986. NTIS, PC A99/MF A01. File Number DE87005940. (CONF-860629—).

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

For a number of years ITEP has been engaged in feasibility studies for an ICF power facility with heavy ion driver. The proposed driver scheme will include RF linac followed by systems for beam storage, compression and transport. Estimates made in ITEP show that the RF linac has to provide a possibility to hit fusion targets with 20 GeV Bi beams and to deliver total energies of 9 MJ (400 TW total power). For a driver being coupled with four fusion reactors the linac will consume 810 MW, assuming linac efficiency to be about 50%. The proposed block-diagram of the RF linac and its performance are discussed. Also, some experimental results obtained during start-up of the first section prototype with a 5 mA Xe^{3+} beam accelerated from 130 keV to 1.35 MeV are presented.

25694 **Operation of general purpose stepping motor controllers at the National Synchrotron Light Source.** Stubblefield, F.W. (Brookhaven National Lab., Upton, NY 11973). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 102-109(Feb 1987). (CONF-861007—). Contract AC02-76CH00016.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

A prototype and four copies of a general purpose subsystem for mechanical positioning of detectors, samples, and beam line optical elements which constitute experiments at the National Synchrotron Light Source facility of Brookhaven National Laboratory have been constructed and placed into operation. Construction of a sixth subsystem is nearing completion. The subsystems effect mechanical positioning by controlling a set of stepping motors and their associated position encoders. The units are general purpose in the sense that they receive commands over a standard 9600 baud asynchronous serial line compatible with the RS-232-C electrical signal standard, generate TTL-compatible streams of stepping pulses which can be used with a wide variety of stepping motors, and read back position values from a number of different types and models of position encoder. The basic structure of the motor controller subsystem is briefly reviewed. Short descriptions of the positioning apparatus actuated at each of the test and experiment stations employing a motor control unit are given. Additions and enhancements to the sub-system made in response to problems indicated by actual operation of the four installed units are described in more detail.

25695 **Snake ring: a feasibility study of a small predamping ring for the positron source of SLC.** Wille, K. (Stanford Univ., CA). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **A238**: 5-11(1985). Contract AC03-76SF00515.

In order to reduce the large emittances of the positron beam, as well as the large energy spread, a radiation damping time of the order of 10 ms is required. By use of a specially designed SNAKE-wiggler with a field of 2 T one can obtain this short damping time at a beam energy of 100 MeV. Because of the strong bending field of the wiggler, the optics of the small model predamping ring presented here, in particular the chromaticity, is mainly determined by the edge focusing at the entrance and exit of each wiggler section. In order to get a uniform damping partition the dispersion function has to have a particular shape which defines the most important optical constraint. 12 references, 6 figures, 4 tables.

25696 **Chopped ion beams for radiation effects simulation.** Lewis, M.B.; Schulze, G.K. (Oak Ridge National Lab., TN). *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms;* **B9**: 100-102(1985). Contract AC05-84OR21400.

The heavy ion source located in the terminal of a 5 MV Van de Graaff has been modified to produce chopped ion-beams useful for studying microstructural phenomena in ion irradiated materials.

25697 **Study and design of a high transmission, high resolution toroidal grating monochromator for soft X-ray radiation.** Chen, C.T.; Plummer, E.W.; Howells, M.R. (Univ. of Pennsylvania, Philadelphia). *Nuclear Instruments and Methods in Physics Research;* **222**: 103-106(1984). Contract AC02-76CH00016.

From 3. national conference on synchrotron radiation instrumentation; Upton, NY, USA (12-14 Sep 1983).

The authors have used a multi-element ray tracing program to study the performance of conventional toroidal grating monochromators-(TGM) and to design a new TGM with significantly higher transmission and resolution. The contribution to the resolution from astigmatic coma of the optical system has been reduced by approximately an order of magnitude, by using a toroidal front mirror. The vertical defocusing contribution to the resolution has been eliminated by utilizing a movable exit slit. 3 references, 6 figures, 1 table.

4304 Storage Rings

REFER ALSO TO CITATION(S) 25543, 25643, 25710

44 INSTRUMENTATION

4401 Radiation Instrumentation

REFER ALSO TO CITATION(S) 24398, 25694, 25830, 25835, 25908, 25909, 26029, 26125, 26317

25698 **(BNL—39281) Improving scintillation crystals using muon tomography.** Dowell, D.H.; Fineman, B.J.; Sandorfi, A.M. (Brookhaven National Lab., Upton, NY (USA)). 1987. Contract AC02-76CH00016. 23p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006912.

The cosmic ray muon scanning array provides information on NaI(T1) crystals using some 65,536 trajectories, each measuring the NaI(T1) response to high energy muons. With this information, it is possible to use established computer-aided-tomography techniques to deconvolute these integrated responses and produce a detailed picture of the detector's interior.

25699 **(DOE/ER/45233—1) Application of spin-sensitive electron spectroscopies to investigations of electronic and magnetic properties of solid surfaces and epitaxial systems: Progress report, January 1, 1986-December 31, 1986.** Walters, G.K.; Dunning, F.B. (Rice Univ., Houston, TX (USA). Dept. of Physics). Aug 1986. Contract FG05-86ER45233. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007937.

Research during the first year of this grant has focussed on: (1) investigation of surface geometrical and magnetic properties by Spin-Polarized Low Energy Electron Diffraction (SPLEED); and (2) investigation of dynamics of metastable atom deexcitation at surfaces by means of Spin-Polarized Metastable Deexcitation Spectroscopy (SPMDS). 6 refs., 4 figs.

25700 **(DOE/EV/04361—T5) Light scattering by microstructures in plastic nuclear track detector plane surfaces.** Wipasuramonton, O. (Clarkson Univ., Potsdam, NY (USA). Dept. of Physics). 15 Aug 1985. Contract AC02-77EV04361. 303p. NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE87007566.

The angular distributions of light elastically scattered by finite dielectric conical and cylindrical microstructures in plastic nuclear track detector plane surfaces have been measured. These microstructures are the chemically etched tracks of various nuclei, viz., protons, neutrons, ^{3}He, alphas, and ^{56}Fe. The base diameters of the structures are larger than twice the wavelength of the incident light. The results show the dependence of the scattering patterns on shape, size, orientation, and refractive index of the structures as well as the polarization of the incident light. It is also observed that in the single and independent scattering regime, the intensity at the intermediate angular region exhibits linear proportionality to the number of the microstructures per unit area. 84 refs., 96 figs., 4 tabs.

25701 (N—87-16742, pp vp) **Development of passive radiation detectors of improved sensitivity.** Chakrabarty, M. R. Nov 1986. NTIS, PC A99/MF E04. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—).

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

The future development of a solid track high energy particle detector is discussed. The goal is to improve the sensitivity and lower the threshold of the detector. One most widely used material for such purpose is a plastic commercially known as CR-39. A scheme is presented which involves changing the formula of the monomer, diethylene glycol-bis-allyl carbonate. This is to be accomplished by substituting some heteroatoms for H and substituting sulfur atoms for oxygen in the ether linkages. Use of a new plasticizer to make the etched surface clearer than what has been accomplished as of today is suggested. Possible improvement in acquiring better tracks and increasing the ratio of V sub T/V sub B was planned. This is to be accomplished by changing the composition of the etchants, etching time, and etching temperature.

25702 (N—87-16742, pp vp) **Automated calibration of a flight particle spectrometer.** Torbert, R.B. Nov 1986. NTIS, PC A99/MF E04. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—).

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

An automatic calibration system was designed for use in the vacuum facility at the Space Science Laboratory of the Marshall Space Flight Center. That system was developed and used in the intervening winter to calibrate the ion spectrometer that eventually flew in May 1986 aboard the NASA project, CRIT 1. During this summer, it is planned to implement the calibration of both an ion and electron spectrometer of a new design whose basic elements were conceived during the winter of 1985 to 1986. This spectrometer was completed in the summer and successfully mounted in the vacuum tank for calibration. However, the source gate valve malfunctioned, and, at the end of the summer, it still needed a replacement. During the inevitable delays in the experimental research, the numerical model of the Critical Velocity effect was completed and these results were presented.

25703 **Fast counting electronics for neutron coincidence counting.** Swansen, J.E. (to Dept. of Energy, Washington, DC). US Patent 4,642,466. 10 Feb 1987. Filed date 5 Mar 1985. vp.

This patent describes a high speed circuit for accurate neutron coincidence counting comprising: neutron detecting means for providing an above-threshold signal upon neutron detection; amplifying means inputted by the neutron detecting means for providing a pulse output having a pulse width of about 0.5 microseconds upon the input of each above threshold signal; digital processing means inputted by the pulse output of the amplifying means for generating a pulse responsive to each input pulse from the amplifying means and having a pulse width of about 50 nanoseconds effective for processing an expected neutron event rate of about 1 Mpps: pulse stretching means inputted by the digital processing means for producing a pulse having a pulse width of several milliseconds for each pulse received form the digital processing means; visual indicating means inputted by the pulse stretching means for producing a visual output for each pulse received from the digital processing means; and derandomizing means effective to receive the 50 ns neutron event pulses from the digital processing means for storage at a rate up to the neutron event rate of 1 Mpps and having first counter means for storing the input neutron event pulses.

25704 **Feedback threshold control extends pulse rate measurements into the pileup region.** Valentine, K.H.; Kopp, M.K.; Williams, J.A. (Instrumentation and Controls Div., Oak Ridge National Lab., Bldg. 3500, Oak Ridge, TN 37831-6008). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 78-81(Feb 1987). (CONF-861007—). Contract AC05-84OR21400.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

By using feedback control of the discrimination threshold we have added 4-6 decades to the useful range of otherwise conventional pulse counting systems. The additional range is obtained at the high end by retarding saturation of the output count rate with higher threshold levels. The authors have implemented the method with low-power microcircuits that provide a 9-decade range (10/ sup -5/ to 10-/sup 4/ R/h) without the need for range or mode switching.

25705 **Pulse filtering for thick mercuric iodide detectors.** Gerrish, V.M.; Williams, D.J.; Beyerle, A.G. (EG & G Energy Measurements, Inc., Santa Barbara Operations, 130 Robin Hill Road, Goleta, CA 93117). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 85-90(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Mercuric iodide (HgI/sub 2/) is a semiconductor material of interest as a gamma-ray spectrometer due to its large band gap and high atomic number, properties which allow room temperature operation and provide high gamma-ray cross section. At EG & G Energy Measurements, Inc. (EG & G/EM), single crystals of mercuric iodide are grown by vapor sublimation and fabricated into detectors of 0.2-12.0 mm thickness. Thin detectors (< 1 mm) produce a good energy resolution (—1%-5% at 662 keV) and work well a x-ray detectors but have low gamma-ray efficiency. Detectors of 1 mm-1 cm thickness provide higher gamma ray efficiency but are limited by poor hole transport properties which degrade detector performance. When conventional pulse shaping is used, energy resolutions of 6%-12% and peak-to-valley ratio < 3:1 are typical for detectors of 1-5 mm thickness. Detectors of — 1-cm thickness typically produce > 10% resolution and peak-to-valley ratios < 2:1. The authors have investigated a number of electronic pulse filtering techniques for thick mercuric iodide detectors and have achieved improved spectral response for detectors of 1-5 mm thickness and gamma ray energies up to 1.5 MeV. Conventional gaussian and gated integration filters were considered as well as more sophisticated filter combinations in order to develop methods of reducing charge measurement errors caused by poor hole collection. When using these techniques, energy resolutions of 3%-6% and peak-to-valley ratios of 5:1 are common. In this paper they discuss these approaches and present results with thick detectors.

25706 **An ultra low noise, low power hybrid preamplifier for X-ray spectrometry.** Iwanczyk, J.S.; Dabrowski, A.J.; Dancy, B.W.; Patt, B.E.; De Vore, T.M.; Del Duca, A.; Ortale, C.; Schnepple, W.F.; Barksdale, J.E.; Thompson, T.J. (Univ. of Southern California, Institute for Physics, 4676 Admiralty Way, Suite 932, Marina del Rey, CA 90292). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 124-126(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

A hybrid preamplifier for use with high resolution HGI/sub 2/ ray detectors have been developed. Full scale discrete component circuits were tested, and the final design was hybridized as a standard 20-pin dip package. The preamplifier can be configured to operate as a resistor or pulsed feedback mode device. In the pulsed light feedback mode the electronic noise measured by the pulser method with the input transistor cooled to approximately -30°C was 19.6 electrons RMS. The equivalent input noise at room temperature was 22 electrons RMS, and the power consumption was 220 mW. In the resistor feedback mode corresponding values of 30 electrons RMS and 200 mW were measured.

25707 **Evaluation of a thin CaF/sub 2/(Eu) scintillator for detecting tritium.** Chiles, M.M. (Oak Ridge National Lab., Bldg. 3500, P.O. Box X, Oak Ridge, TN 37831-6006). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 386-388(Feb 1987). (CONF-861007—). Contract AC05-84OR21400.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The primary objective of this project was to investigate the feasibility of using a CaF/sub 2/ (Eu) scintillator for detecting low-energy beta particles from tritium. A proof-of-principle detector was designed to flow tritium-spiked nitrogen gas across the surface of a thin scintillator, which was optically coupled between two low-noise photomultiplier tubes. Electronics for operating two photomultiplier tubes in coincidence eliminated most of the tube noise pulses and allowed detection of small pulses from the low-energy tritium beta particles.

25708 **The analog processing system for the Liquid Argon Calorimeter for SLD at SLAC.** Haller, G.M.; Nelson, D.; Freytag, D.R. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 170-174(Feb 1987). (CONF-861007—). Contract AC03-76SF00515.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The analog processing system for the Liquid Argon Calorimeter for the SLD project at SLAC is described. Amplification, storage of the analog information, and multiplexing is realized on specially developed hybrids, which will be mounted directly on the detector. This leads to a substantial reduction of the cable plant. Test results for the amplifier and for the sampling and multiplexing hybrid (CDU hybrid) are presented. The latter hybrid contains a custom monolithic device, the Calorimeter Data Unit (CDU).

25709 **100 MBS, 8 bit data acquisition and zero suppression system for the DO detector.** Martin, M.I.; Johnson, M.E.; Mayberry, M.J.; De Groot, D.C. (Fermi National Accelerator Lab., P.O. Box 500, Batavia, IL 60510). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 258-260(Feb 1987).

The DO central tracking system produces a wide range of waveforms that must be digitized at a rate greater than 80 MHz. The 8,224 channels in this system create over two megabytes of data for every p-bar p crossing. Such a data rate can be tolerated if the null data is removed before it reaches the first data bus. We describe the tracking system's 8 bit, 100 megasample per second digitizer and a channel-level, data reduction device implemented in a semi-custom integrated circuit.

25710 **The DELPHI barrel electromagnetic calorimeter flash ADC based digitizer.** Crawley, H.B.; Gorbics, M.S.; Holland, G.E.; Homer, J.F. Jr.; McKay, R.; Meyer, W.T.; Rosenberg, E.I.; Thomas, W.D. (Dept. of Physics and Ames Lab., USDOE, Iowa State Univ., Ames, IA 50011). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 261-265(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The authors describe the design and performance of an 8-bit Flash ADC based readout system developed for use on the cathode pads of the DELPHI High Density Projection Chamber (HPC). A dynamic range of 800:1 is obtained at input frequencies of 15 MHz using a bilinear voltage divider reference chain. Performance characteristics of the digitizing circuits for a CAMAC version of this readout system are presented. The design of a FASTBUS version is presented.

25711 **Radiation detection algorithm for a portable survey instrument.** Staley, H.C.; Unruh, W.P.; Baird, W.; Worth, G.M. (Instrument Technologies Group, Los Alamos National Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 619-621(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Los Alamos has developed two detector probes, one for gammas and the other for alphas, that can be connected to any device, such as a terminal or computer, capable of sending and receiving serial ASCII data. The authors were faced with the problem of developing computer programs that would allow the probes to be used in either a survey or a measurement mode and give good statistical response in either. To test different algorithms using various parameters, the authors coded the algorithms in the Pascal programming language and ran them on a personal computer. The advantage of programs employing the algorithms the authors have developed is that they are both fast and accurate, but not at the same time. The probes, using these programs, are able to find then measure a source.

25712 **Silicon radiation detectors with oxide charge state compensation.** Goulding, F.S. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 396-400(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

This paper discusses the use of boron implantation on high resistivity P type silicon before oxide growth to compensate for the presence of charge states in the oxide and oxide/silicon interface. The presence of these charge states on high resistivity P type silicon produces an inversion layer which causes high leakage currents on N/sup +/P junctions and high surface conductance. Compensating the surface region by boron implantation is shown to result in oxide passivated N/sup +/P junctions with very low leakage currents and with low surface conductance.

25713 **Gain reduction due to space charge at high counting rates in multiwire proportional chambers.** Smith, G.C.; Mathieson, E. (Instrumentation Div., Brookhaven National Lab., Upton, NY 11973-5000). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 410-413(Feb 1987). (CONF-861007—). Contract AC02-76CH00016.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Measurements with a small MWPC of gas gain reduction, due to ion space charge at high counting rates, have been compared with theoretical predictions. The quantity iotan(q/q/sub o/)/(q/q/sub o/), where (q/q/sub o/) is the relative reduced avalanche charge, has been found to be closely proportional to count rate, as predicted. The constant of proportionality is in good agreement with calculations made with a modified version of the original, simplified theory.

25714 **New method of gamma dose-rate measurement using energy-sensitive counters.** Kopp, M.K.; Valentine, K.H.; Williams, J.A.; Bamberger, R.H. (Oak Ridge National Lab., P.O. Box X, Oak Ridge, TN 37831-6008). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 616-618(Feb 1987). (CONF-861007—). Contract AC05-84OR21400.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

A new concept of charge quantization and pulse-rate measurement was developed to monitor low-level gamma dose rates using energy-sensitive, air-equivalent counters. Applying this concept, the charge from each detected photon is quantized by level-sensitive comparators so that the resulting total output pulse rate is proportional to dose rate. The concept was tested with a proportional counter and a solid-state detector for wide-range dose-rate monitoring applications. The prototypic monitors cover a dose-rate range from background radiation levels (10 μR/h) to 10 R/h.

25715 **Wire aging of hydrocarbon gases with TMAE additions.** Va'vra, J. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 486-490(Feb 1987). (CONF-861007—). Contract AC03-76SF00515.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The authors report on experimental results describing wire aging properties of the CRID/RICH detectors in the TMAE gas environment. This test used 7 μm and 33 μm diameter carbon fibers, and 20 μm diameter gold-plated tungsten wires as sense wires, and operated in gas mixtures of either CH/sub 4/ or C/sub 2/H/sub 6/ at 1 atm, together with 0.6 Torr of the photoionizing vapor TMAE (tetrakis dimethylamino ethylene), which serves as a photocathode in the CRID detectors. The wires were damaged by the Fe/sup 55/ X-rays. This paper is based on irradiation of 20 wires, each being a separate test. The gas purity was consistent with requirements of CRID detectors (< 1 ppm of oxygen, < 1 ppm of water). The test explored the aging as a function of wire diameter, wire material, gas flow, gas temperature, rate of radiation and gas type. Several chemical analyses of the deposit samples were performed (FTIR, ESCA and GC-MS techniques).

25716 **Progress report on the SLD Cerenkov Ring Imaging Detector.** Ashford, V.; Bienz, T.; Bird, F.; Crawford, G.; Gaillard, M.; Hallewell, G.; Leith, D.; Kwon, Y.; McShurley, D.; Nuttall, A. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 499-503(Feb 1987). (CONF-861007—). Contract AC03-76SF00515;AT03-76ER70023.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The authors describe test beam results from a prototype Cerenkov Ring Imaging Detector (CRID) for the SLD experiment at the SLAC Linear Collider (SLC). The system includes both liquid and gas radiators, a long drift box containing gaseous TMAE and a proportional wire chamber with charge division readout. Measurements of the multiplicity and detection resolution of Cerenkov photons, from both radiators are presented. Various design aspects of a new engineering prototype, currently under construction, are discussed and recent R&D results relevant to this effort are reported.

25717 **Wire chamber aging and wire material.** Atac, M. (Fermi National Accelerator Lab.). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 476-480(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Recent studies on wire chamber aging have shown surprising results indicating that anode wire material may have a strong influence on the useful life-time of a chamber or counter. The aging process discussed here is related to changes in the surface characteristics of the anode wires. Those changes may be due to an oxidation process involving molecules produced from the dissociation of organic quenching agents during the avalanche process. It is observed that after some running time the anode wire surface is coated with a nonconductive film, which drops the electric field around the anode wire, reducing the gain as the aging process continues. Aging was accelerated when the gold plated tungsten anode wire was replaced by Stablohm-800 resistive alloy (75% Ni + 20% Cr + Al + Cu) wire using the same gas in the same chamber. However, the gas mixture of Argon-ethane-isopropyl alcohol provides a very long lifetime for a drift chamber made of Stablohm-800 anode wire. The details of the findings are discussed.

25718 **Anode wire aging measurements and a search for remedies.** Juricic, I.; Kadyk, J.A. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 481-485(Feb 1987). (CONF-861007—). Contract AC03-76SF00098.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

As part of a continuing investigation into the aspects of the aging process induced by radiation, measurements have been made of anode wire gain loss in a typical gain region. This has been done for several gas mixtures, but with emphasis on measurements of 50% argon + 50% ethane. Parameters such as gain, gas flow rate and small concentrations of certain additives were investigated to determine their effects on the gain loss rate. The effects of ethanol, water, and isopropanol vapor at about 1% concentration were studied, as well as potential contributions to aging from different types of plastic tubing in the gas system. The results were found to be quite sensitive in certain cases to the wire surface material, to additives such as the alcohols tested, and to small gas impurities. Certain pure gas mixtures were found to be consistent with no aging at the sensitivity level of this technique.

25719 **Performance characteristics studies of image intensifier having short luminescence decay time.** Leskovar, B.; Jerbic, E.J.; Zizka, G. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 453-457(Feb 1987). (CONF-861007—). Contract AC03-76SF00098.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The characteristics of a modified first generation 40 mm-diameter VARO 1248-1 image intensifier which uses a very short luminescence decay time phosphor screen (P-46) have been investigated. Some typical intensifier characteristics - such as luminous gain and spatial resolution - are compared with data provided by the manufacturer for nonmodified device. Characteristics which are not generally available from manufacturer were also measured. These include the phosphor spectral emission characteristics and luminescence decay time. The measuring techniques used and description of measuring systems are given.

25720 **Time resolution performance studies of Hamamatsu R1564U microchannel plate photomultiplier.** Leskovar, B.; Shimizu, T.T. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 427-430(Feb 1987). (CONF-861007—). Contract AC03-76SF00098.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Time resolution characteristics of the Hamamatsu R1564U 18 mm-diameter photomultiplier have been investigated. This new prototype high gain photomultiplier has two microchannel plates in cascade for electron multiplication. Some typical photomultiplier characteristics-such as gain, dark current, and output pulse rise and fall times-are compared with data provided by the manufacturer. Photomultiplier characteristics, generally not available from the manufacturer, such as the single photoelectron time spread and pulse-height spectrum for full photocathode illumination, were measured and are discussed.

25721 **Calculation of Si(Li) x-ray detector efficiencies.** Zaluzec, N.; Holton, R. (Argonne National Lab., Argonne, IL 60439). pp 353-357 of Analytical electron microscopy. Williams, D.B.; Joy, D.C. San Francisco, CA; The San Francisco Press Inc. (1984). (CONF-840767—).

From Microbeam Analysis Society analytical electron microscopy meeting; Bethlehem, PA, USA (16 Jul 1984).

The calculation of detector efficiency functions is an important step in the quantitative analysis of x-ray spectra when approached by a standardless technique. In this regard, it becomes essential that the analyst not only model the physical aspects of the absorption and transmission of the various windows present, but also use the most accurate data available for the mass absorption coefficients required in these calculations. The topic of modeling the size and shape of the windows present is beyond the scope of this paper and the authors instead concentrate on the mass absorption coefficients used in the calculations and their implications to efficiency calculations. For the purposes of this paper, the authors consider that the relative detector efficiency function of a conventional Si(Li) detector can be modeled by a simple expression.

4402 Radiation Effects On Instrument Components, Instruments, Or Electronic Systems

REFER ALSO TO CITATION(S) 25715, 25718

25722 **Radiation hardness and annealing tests of a custom VLSI device.** Breakstone, A.; Parker, S.; Adolphsen, C.; Litke, A.; Schwarz, A.; Turala, M.; Luth, V. (Univ. of Hawaii, Honolulu, HI 96822). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 491-494(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Several NMOS custom VLSI ("Microplex") circuits have been irradiated with a 500 rad/hr /sup 60/Co source. With power of three of four chips tested have survived doses exceeding 1 Mrad. With power on at a 25% duty cycle, all chips tested failed at doses ranging from 10 to 130 krad. Annealing at 200°C was only partially successful in restoring the chips to useful operating conditions.

4403 Miscellaneous Instruments

REFER ALSO TO CITATION(S) 25243, 25366, 25866, 26070, 26114

25723 **(CONF-870516—2) Gas mixtures for spark gap closing switches with emphasis on efficiency of operation.** Christophorou, L.G.; McCorkle, D.L.; Hunter, S.R. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA). Dept. of Physics). 1987. Contract AC05-84OR21400. 9p. NTIS, PC A02. File Number DE87006624.

From 5. international symposium on gaseous dielectrics; Knoxville, TN, USA (3 May 1987).

The efficient operation of a spark gap closing switch requires a gaseous medium with large breakdown strength, low conduction voltage, and a short formative time lag. Gas properties necessary to achieve these requirements are identified and discussed. Based on available knowledge of such properties, a number of binary (e.g., c-C_4F_8, or l-C_3F_6, or n-C_4F_{10}, or C_3F_8, or C_6F_6 in Ar or He or H_2) and ternary gas mixtures (e.g., c-C_4F_8, or n-C_4F_{10}, or C_3F_8 in Ar or He + C_2H_2 or another low ionization onset additive) have been identified which may be suitable for use in spark gap closing switches.

25724 **(DOE/ET/29372—5) Power system applications of fiber optic sensors.** Johnston, A.R.; Jackson, S.P.; Kirkham, H.; Yeh, C. (Jet Propulsion Lab., Pasadena, CA (USA)). Jun 1986. Contract AI05-79ET29372. 83p. (JPL-PUB—86-22). NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87005417.

Three topics are covered: Electric Field Measurement, Fiber Optic Temperature Sensing, and Optical Power Transfer. Work was done on the measurement of ac and dc electric fields. A prototype sensor for measuring alternating fields was made using a very simple electroscope approach. An electronic field mill sensor for dc fields was made using a fiber optic readout, so that the entire probe could be operated isolated from ground. There are several instances in which more precise knowledge of the temperature of electrical power apparatus would be useful. This report describes a number of methods whereby the distributed temperature profile can be obtained using a fiber optic sensor. The ability to energize electronics by means of an optical fiber has the advantage that electrical isolation is maintained at low cost. In order to accomplish this, it is necessary to convert the light energy into electrical form by means of photovoltaic cells. JPL has developed an array of PV cells in gallium arsenide specifically for this purpose. This work is described.

25725 **(N—87-13362) Space infrared telescope facility wide field and diffraction limited array camera (IRAC). Semiannual status report, 1 March-31 August 1986.** Fazio, G.G. (Smithsonian Astrophysical Observatory, Cambridge, MA (USA)). Oct 1986. 69p. (NASA-CR—177041; NAS—1.26:177041; SASR—4). NTIS, PC A04/MF A01.

IRAC focal plane detector technology was developed and studies of alternate focal plane configurations were supported.

While any of the alternate focal planes under consideration would have a major impact on the Infrared Array Camera, it was possible to proceed with detector development and optical analysis research based on the proposed design since, to a large degree, the studies undertaken are generic to any SIRTF imaging instrument. Development of the proposed instrument was also important in a situation in which none of the alternate configurations has received the approval of the Science Working Group.

25726 **(N—87-15524) Field test to intercompare carbon monoxide, nitric oxide and hydroxyl instrumentation at Wallops Island, Virginia.** Gregory, G. L.; Beck, S. M.; Bendura, R. J. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Jan 1987. 173p. (NASA-TM—87718; L—16126; NAS—1.15:87718). NTIS, PC A08/MF A01.

Documentation of the first of three instrument intercomparisons conducted as part of NASA Global Tropospheric Experiment/Chemical Instrumentation Test and Evaluation (GTE/CITE-1) is given. This ground-based intercomparison was conducted during July 1983 at NASA Wallops Flight Facility. Instruments intercompared included one laser system and three grab-sample approaches for CO; two chemiluminescent systems and one laser-induced fluorescent (LIF) technique for NO; and two different LIF systems and a radiochemical tracer technique for OH. The major objectives of this intercomparison was to intercompare ambient measurements of CO, NO, and OH at a common site by using techniques of fundamentally different detection principles and to identify any major biases among the techniques prior to intercomparison on an aircraft platform. Included in the report are comprehensive discussions of workshop requirements, philosophies, and operations as well as intercomparison analyses and results. In addition, the large body of nonintercomparison data incorporated into the workshop measurements is summarized. The report is an important source document for those interested in conducting similar large and complex intercomparison tests as well as those interested in using the data base for purposes other than instrument intercomparison.

25727 **(N—87-16729) Photoabsorption and photodissociation of molecules important in the interstellar medium. Annual report, 15 May 1986-14 January 1987.** Lee, L.C.; Suto, M. (San Diego State Univ., CA (USA)). Jan 1987. 52p. (NASA-CR—180101; NAS—1.26:180101). NTIS, PC A04/MF A01.

A windowless apparatus was constructed and used to measure the photoabsorption and fluorescence cross sections of molecules in the extreme ultraviolet region. Photoabsorption and fluorescence cross sections of H_2O, D_2O, H_2S, D_2s, and CO were measured in the 50 to 200 nm region. These quantitative data are currently needed for the determination of the formulation and destruction rates of molecules in the interstellar medium.

25728 **(SAND—87-0072) An analysis of ion spectrometry.** Aronson, E.A. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 51p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007953.

Ion Mobility Spectrometry (IMS) is used to determine whether ions of a certain species exist in a collection of ions. Analytical models of IMS are presented for Pulse IMS (PIMS) and Fourier Transform IMS (FTIMS) systems. The basic structure of the models divide the sensor output into signal, clutter, and noise components. Convolution-like equations are derived for gating at various positions in the IMS measurement tube. Design criteria and a signal-averaging method are presented for PIMS. Analytic expressions are given for the basic FTIMS processing as well as an analysis of resolution limitations and ion diffusion. A model of the electrostatic field in the ion tube and at the entrance gate is derived. This model is used to suggest methods of quantification of imperfect gating and gate depletion so that these important causes of signal-to-noise losses may eventually be alleviated or eliminated.

25729 **Semiautomated PVT facility for fluids and fluid mixtures.** Linsky, D.; Levelt Sengers, J.M.H.; Davis, H.A. (Thermophysics Division, Center for Chemical Engineering, National Bureau of Standards, Gaithersburg, Maryland 20899). *Review of Scientific Instruments;* **58**: No. 5, 817-821(May 1987).

A manually operated Burnett apparatus has been converted into a semiautomated Burnett—isochoric PVT facility. An automated pressure injector with dedicated control logic nulls a sensitive differential pressure indicator. A microcomputer is used in setting the control temperature, monitoring equilibration, measuring temperature and pressure, processing the raw data, and storing the information. The quality of the apparatus is demonstrated by means of a low-density and a high-density isochore obtained for a geothermal working fluid mixture in one-phase, two-phase, and supercritical regimes, including a dew and a bubble point.

25730 **Apparatus for making superlattice Langmuir—Blodgett films with atmosphere and temperature control.** Armen, T.; Halperin, K.; Dutta, P.; Ketterson, J.B. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201). *Review of Scientific Instruments;* **58**: No. 5, 822-825(May 1987).

We describe an instrument consisting of two adjacent Langmuir troughs and an apparatus capable of dipping substrates in either trough. Such a capability permits the fabrication of Langmuir—Blodgett multilayer films consisting of two alternating components. The troughs are housed in a hermetically sealed enclosure which may be evacuated to permit the establishment of a clean and/or modified (e.g., O_2 free) atmosphere. The enclosure is double walled for circulation of thermostating fluid (e.g., ethylene glycol) in order to establish temperatures in the range -30 to 130 °C. The monolayer pressures, film size, and dipping sequence can be controlled manually or by a computer. The surface pressure in each trough is sensed by independent Cahn balances employing filter paper "Wilhelmy plates" in such a manner as to maintain the hermetic seal.

25731 **Study of condensational growth of water droplets by Mie resonance spectroscopy.** Fung, K.H.; Tang, I.N.; Munkelwitz, H.R. (Brookhaven National Laboratory, Department of Applied Science, Environmental Chemistry Division, Upton, New York 11973). *Applied Optics;* **26**: No. 7, 1282-1287(1 Apr 1987). Contract AC02-76CH00016.

An optical technique using MIE resonance scattering spectroscopy to monitor the growth of a saline solution droplet is presented. This technique utilizes a quadrupole particle trap to suspend a charged NaCl solution droplet in water vapor environment and a CO_2 laser to momentarily perturb the droplet-vapor equilibrium. The condensational growth of this droplet is monitored by means of multiple Mie resonances observed at right angle sccattering. A least-squares fit, used to evaluate the condensation coefficient of water, shows that the value tends to approach unity. In addition, this new approach reduces the error in dry salt size measurement to $<1\%$.

25732 **Apparatus for determining the filling pressure of a plurality of microballoons.** Jorgensen, B.S. (to Dept. of Energy, Washington, DC). US Patent 4,650,328. 17 Mar 1987. Filed date 5 Jun 1984. vp.

An apparatus is described for determining the filling pressure of a plurality of microballoons, which comprises in combination: a. an optically transparent plate having a substantially flat surface; b. a rod affixed to the substantially flat surface of the optically transparent plate for removably attaching the microballoons, the rod being located substantially parallel to the transparent plate, and having a sticky substance thereon; and c. means for interferometrically scanning each of the microballoons both before and after the filling thereof in order to determine the gas fill pressure. The individual microballoons are attached sufficiently rigidly to the rod to permit the means for interferometrically scanning each of the microballoons to measure substantially the same microballoon orientation before and after the filling thereof.

25733 **Apparatus and method for void/particulate detection.** Claytor, T.N.; Ockert, C.E.; Randall, R. (to Dept. of Energy). US Patent Application 6-877,959. 24 Jun 1986. 22p. Contract W-31109-ENG-38. DE87007190 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007190.

Apparatus and method are described for detecting voids and particulates in a fluid within a containing vessel. A diffuse ultrasonic signal is coupled into the fluid by a first transducer and the portion of the ultrasonic signal transmitted through the fluid is detected by a second transducer. The received signal is analyzed by a processor to determine the void fraction of the fluid responsive to the attenuation of the received ultrasonic signal. In addition, voids and particulates are detected by evaluating the increase in side-band energy of the received signal.

25734 **Optical sensor of magnetic fields.** Butler, M.A.; Martin, S.J. (to Dept. of Energy). US Patent Application 6-844,043. 25 Mar 1986. 24p. Contract AC04-76DP00789. DE87007222 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007222.

An optical magnetic field strength sensor for measuring the field strength of a magnetic field comprising a dilute magnetic semiconductor probe having first and second ends, longitudinally positioned in the magnetic field for providing Faraday polarization rotation of light passing therethrough relative to the strength of the magnetic field. Light provided by a remote light source is propagated through an optical fiber coupler and a single optical fiber strand between the probe and the light source for providing a light path therebetween. A polarizer and an apparatus for rotating the polarization of the light is provided in the light path and a reflector is carried by the second end of the probe for reflecting the light back through the probe and thence through the polarizer to the optical coupler. A photo detector apparatus is operably connected to the optical coupler for detecting and measuring the intensity of the reflected light and comparing same to the light source intensity whereby the magnetic field strength may be calculated.

25735 **Soft x-ray measurements of solid Fabry-Perot etalons.** Bartlett, R.J.; Trela, W.J.; Kania, D.R.; Hockaday, M.P.; Barbee, T.W. Jr.; Lee, P. (Los Alamos National Lab., NM). *Optics Communications;* **55**: No. 4, 229-235(15 Sep 1985).

Soft X-ray measurements of the reflected spectrum from solid Fabry-Perot etalons were made using the Stanford Synchrotron Radiation soft X-ray beam lines. Each etalon was formed from two layered synthetic microstructures (LSM) separated by a carbon spacer. The etalons were formed using sputter deposition techniques on Si wafer substrates. Two such etalons were tested, each having LSM mirrors consisting of 10 layer pairs of W (20 A) and C (31 A) and spacer thicknesses of 620 A and 155 A, respectively. The measured response of the etalons is compared with calculations. The qualitative agreement is very good but the reflected spectrum is only about 50% of the calculated value. Interfacial roughness, substrate figure, and X-ray beam divergence can easily account for this discrepancy. 10 references, 4 figures, 1 table.

25736 **Large-angle convergent-beam electron diffraction: a simple technique for the study of modulated structures with application to V_2D.** Taftoe, J.; Metzger, T.H. (Brookhaven National Lab., Upton, NY). *Journal of Applied Crystallography;* **18**: 110-113(1985). Contract AC02-76CH00016.

With a highly convergent electron beam entering a small crystal area, the Bragg condition may be fulfilled simultaneously for many diffraction orders along a reciprocal-lattice direction, and reflections with (sin theta)/λ > 2 A^{-1} are accessible. Considerations based on the dynamical theory of electron diffraction suggest that for Bragg reflections with (sin theta)/λ > 1A^{-1}, 100 keV electrons can be treated quasi-kinematically when the crystal thickness is less than 1000 A, and this is supported by experiments. This simple approach has been used to determine the D-induced static displacement modulation δ of V along the a axis (monochlinic indexing) in the β phase of V_2D. from visual inspection of the Bragg intensities for large diffraction orders, up to (sin theta)/λ = 2.35 A^{-1}, it is concluded that δ = 0.070 (5) A. 17 references, 4 figures.

25737 **Radiation-induced thermal noise in optoacoustic detection cells.** Stewart, R.B.; Diebold, G.J. (Brown Univ., Providence, RI). *Journal of Applied Physics;* **56**: No. 7, 1992-1996(1 Oct 1984). Contract FG02-84ER13235.

When radiation is strongly absorbed in an optoacoustic detection cell, fluctuations in the radiation intensity give rise to thermal noise within the cell. The spectral density of the thermal noise thus generated is dependent on both the frequency response of the cell and the power spectral density of the radiation source. The frequency response function for the spectrophone cell is determined by application of elementary linear response theory to a solution of the heat equation for a uniformly heated cylinder. The power spectral density of coherent and incoherent radiation sources can be determined from their respective intensity autocorrelation functions. Radiation sources are discussed with regard to obtaining the smallest root-mean-square temperature fluctuations in the spectrophone cell. It is shown that optoacoustic noise is minimized by using a stabilized laser operating well above threshold. 15 references, 1 figure, 1 table.

25738 **Weighing lysimeters for long-term water balance investigations at remote sites.** Kirkham, R.R.; Gee, G.W.; Jones, T.L. (Battelle Pacific Northwest Lab., Richland, WA). *Soil Science Society of America Journal;* **48**: No. 5, 1203-1205(Sep-Oct 1984). Contract AC06-76RL01830.

Two weighing lysimeters were installed at a remote location on the Dep. of Energy's Hanford Site in Washington State in 1978 and 1979. Platform-type electronic scales were placed below the soil surface to measure the weight changes of a large (~ 7 Mg) container of soil. The load cells of the scales have been exposed to high humidity and to periodic contact with drainage water, but have operated without failure since installation (over 5 years). Weight changes are continuously recorded, with hourly averages transmitted by phone line directly to the laboratory. The sensitivity of the scale is 50 g, equivalent to 0.02 mm of H_2O. 7 references, 4 figures.

25739 **Synchrotron X-ray powder diffraction.** Hastings, J.B.; Thomlinson, W.; Cox, D.E. (Brookhaven National Lab., Upton, NY). *Journal of Applied Crystallography;* **17**: 85-95(1984). Contract AC02-76CH00016.

The application of synchrotron X-ray radiation to powder diffraction is described. A perfect Si double-crystal monochromator at the Cornell High Energy Synchrotron Source (CHESS) was used in conjunction with Si, Ge, LiF and Al_2O_3 analyzers to investigate resolution and intensity characteristics at selected wavelengths between 1.07 and 1.54 A. The results obtained with Ge at 1.54 A gave a resolution Δd/d of 5 x 10^{-4} at 2 theta = 30°, falling to 2 x 10^{-4} at 2 theta = 140°. Analysis of the peak shapes is described in detail, with particular emphasis on the asymmetry observed at angles below 50° due to axial divergence effects. With a simple correction to allow for these, the peak shapes are found to be well represented by a convolution of Gaussian and Lorentzian components, the respective peak widths of these being related to the intrinsic resolution and sample broadening effects. It is pointed out that the use of a crystal analyzer should eliminate shifts in the Bragg-peak positions owing to the displacement-type aberrations which occur with conventional focusing-type diffractometers. Except for a constant zero error, the mean discrepancy in observed and calculated peak positions between 0 and 90° for reference samples CeO_2, Al_2O_3 and NiO is found to be only about 0.003°. Finally, some general remarks are made about the application of the Rietveld profile technique to structural analysis from synchrotron powder diffraction data. 31 references, 7 figures, 8 tables.

25740 **Bloch wave HREM.** Marks, L.D. (Arizona State Univ., Tempe). *Ultramicroscopy;* **14**: 351-356(1984). Contract AC02-76ER02995.

An analysis of the effects of beam convergence is carried out for high resolution electron microscope imaging, including the changes in diffraction across the illumination aperture by a Bloch wave approach. It is shown that the effect of a small tilt u is to introduce a perturbation U x del/sub rho/ into the projected 2D Schroedinger equation for the Bloch waves. By using perturbation theory (essentially a k x p analysis), it is shown that the dominant effect is a modification of the non-linear convergence envelope term between different Bloch waves. The effects should be larger for defects than for single crystals, and important for thicknesses of more than ~ 50 nm, thicknesses similar to those at which non-linear effects are important. The general trends with structure, elemental composition and incident electron voltage are briefly described. 16 references, 1 figure.

45 EXPLOSIONS AND EXPLOSIVES

25741 (SAND—86-1785C) **Microwave coupling inside complex systems.** Toth, R.P.; Bacon, L.D. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 4p. (CONF-861240—15). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003505.

From 3. national conference on high power microwave technology for defense applications; Albuquerque, NM, USA (1 Dec 1986).

In order to understand the parameters which contribute to microwave coupling phenomenon in complex systems, it is first necessary to investigate the problem using simple, easily modeled systems. To that goal, we define the term "complex systems" to mean hollow, cylindrically shaped test objects with one or more apertures and an internal sensor of known characteristics. Our objective in this work is to determine the effect of complex clutter inside a weapon system on the propagation of microwaves from their entry point to the terminals of vulnerable electronic subsystems. Our approach is to measure the response of representative geometries, using low-power cw illumination over the frequency range of 100 MHz to 18 GHz. We were particularly interested in the effect of lossy materials on the interaction of multiple apertures.

4501 Chemical

25742 (MLM—3393(OP)) **Corrosion of gold bridgewire in electronic components.** Downs, G.L.; Braun, J.D.; Tibbitts, E.E. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 1986. Contract AC04-76DP00053. 20p. (CONF-8608153—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000922.

From International Metallographic Society conference on microstructural science; Boston, MA, USA (3 Aug 1986).

Accelerated aging tests on gold bridgewired detonator assemblies to determine compatibility of the Au and Pd-In-Sn solder with the organic explosive, PENT, have revealed an unusual corrosion process. These tests, conducted at 74°C and 54°C indicated a preferential attack of the gold. A matrix of corrosion test units was established to study this corrosion problem with accelerating temperatures up to 100°C. Scanning electron microscopy (SEM), energy dispersive x-ray (EDX), and x-ray diffraction techniques were used to determine the extent of the corrosion and identify the corrosion products. Results indicate the preferential attack of the gold was due to HCN formed by decomposition of the explosive powder (PETN) at high temperatures. Other associated reactions were also observed including subsequent attack of the solder by the gold corrosion product and degradation of the plastic header.

25743 (MLM—3413(OP)) **Low energy ignition of HMX using a foil bridge.** Ewick, D.W. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 1986. Contract AC04-76DP00053. 11p. (CONF-861230—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004211.

From 13. symposium on explosives and pyrotechnics; Hilton Head Island, SC, USA (2 Dec 1986).

The use of an etched foil bridge to initiate the deflagration of high-density HMX is described. Two foil bridges were evaluated, each having a cross-sectional area approximately equal to that of a 0.0034-in. diameter bridgewire. One foil was 0.11 in. wide and 0.0008 in. thick; the other was 0.022 in. wide and 0.0004 in. thick. The all-fire current for the 0.022-in. wide foil bridge was roughly 15% greater than that of the 0.011-in. wide foil, which in turn was approximately 7% greater than the round wire bridge. The no-fire current for the 0.022-in. wide foil bridge was roughly 26% greater than that of the 0.011-in. wide foil, which in turn was approximately 10% greater than the round wire bridge. 7 refs., 4 figs., 3 tabs.

25744 (SAND—86-2211, pp 17-62) **SCB explosive studies.** Bickes, R.J. Jr. Jan 1987. NTIS, PC A07/MF A01. File Number DE87005620.

In Semiconductor bridge (SCB) development technology transfer symposium.

A semiconductor bridge (SCB) that is formed out of heavily doped silicon is described. The width of the bridge is determined by the width of the narrow silicon region connecting the large silicon pads and the length of the bridge is defined by the spacing of the overlaid aluminum lands. The lands provide a means for electrical connection to the bridge. Two materials, silicon-on-graphite and polysilicon-on-silicon, have been used for processing SCBs. The development, safety, and performance of these devices are discussed.

25745 (SAND—86-2211, pp 67-68) **Processing of semiconductor bridges (SCB) in polycrystalline silicon films.** Chen, H.Y.; Jungling, K. (Univ. of New Mexico, Albuquerque). Jan 1987. NTIS, PC A07/MF A01. File Number DE87005620.

In Semiconductor bridge (SCB) development technology transfer symposium.

The processing of semiconductor bridges in a polysilicon film is discussed. These devices are much larger in dimensions when compared with a standard integrated circuit; thus, intrinsic masking errors and overetching during processing are not significant. The most challenging fabrication steps to obtain one-ohm SCB devices are: (1) heavily doping the polysilicon films to obtain a resistivity of 7.6 x 10^{-4} ohm-cm; and (2) making ohmic contracts such that the contact resistance is much less than one ohm. These steps are discussed.

25746 (SAND—86-2211, pp 73-90) **Semiconductor bridge (SCB) packaging.** Blankenship, D.M. Jan 1987. NTIS, PC A07/MF A01. File Number DE87005620.

In Semiconductor bridge (SCB) development technology transfer symposium.

The packaging of semiconductor bridge (SCB) devices is discussed. As it is the ultimate intention to apply silicon bridgewire technology to real explosive devices it is necessary to consider exactly how one can economically package a single SCB die in a configuration that will allow it to function reliably in the manner intended. The most basic packaging requirements for an SCB device are as follows: (1) that the explosive material be in intimate contact with the silicon bridge; (2) that the packaging provide the necessary electrical connections to the bridgewire; (3) that the package be hermetic; and (4) that all materials and metallurgy used in the bridgewire, interconnects, and package be compatible with each other and the explosive material used in a given component. These requirements are discussed.

25747 (SAND—86-2211, pp 95-96) **Unique features of SCBs.** Wilcox, P.D. Jan 1987. NTIS, PC A07/MF A01. File Number DE87005620.

In Semiconductor bridge (SCB) development technology transfer symposium.

The unique features of SCBs will lead to their use in several explosive applications and will also permit their incorporation into new high tech explosive devices are discussed. SCBs generate a hot plasma for the ignition of the explosive powder pressed against the bridge. Ignition is via a microconvective mechanism and not merely a thermal conductive heat transfer process as with hot wires. An examination of the threshold data reveals similar energies for the different powders tested to date indicating that once sufficient energy is supplied to the SCB to burst it into the plasma, ignition will take place. In fact, studies show that the energy required for the late time discharge in a type 3-2 SCB is approximately 1.1 mJ. Ignition energies for SCBs are one-tenth that of conventional bridgewires and foils.

25748 (SAND—86-2211, pp 101-116) **Semiconductor bridge discharge characterization.** Benson, D.A. Jan 1987. NTIS, PC A07/MF A01. File Number DE87005620.

In Semiconductor bridge (SCB) development technology transfer symposium.

A series of measurements which illustrate the primary features of the semiconductor bridge (SCB) discharge is described.

These tests provide the basic parameters fundamental to the design of a SCB element for applications based on thermal ignition of explosives. Among the characteristics of the SCB are inherent low energy requirements of the bridge and an output in the form of a high-temperature plasma which is particularly efficient in igniting granular explosive materials. These characteristics enable the design of devices capable of functioning with low electrical drive voltages. At the same time, effective heat transfer from the silicon thin film to the substrate appears to provide good no-fire characteristics. The information was derived from high-speed framing photography correlated with time resolved measurements of current through and electrical potential across the bridge. Although many of these tests have been run on free standing bridges in air, sufficient tests with powders or solids pressed against the bridges have been made to determine the effects of confinement on explosive applications. More than 20 different SCB geometries, many over a wide range of operating conditions, have now been studied. Results from a few of these tests are given to show the primary features of the bridge operation.

25749 (SAND—86-2211, pp 121-130) **SCB plasma spectroscopy.** Renlund, A.M.; Trott, W.M. Jan 1987. NTIS, PC A07/MF A01. File Number DE87005620.

In Semiconductor bridge (SCB) development technology transfer symposium.

To gain a better understanding of SCB behavior, the emission from these devices was examined over the wavelength range of 180-700 nm. The primary goals in these studies were to identify important emitting species and to estimate the plasma temperatures achieved in functioning SCBs. Additionally, the time-dependence of the emission was examined and correlated with the voltage waveforms.

25750 (SAND—86-2211, pp 135-146) **SCB heat transfer.** Larsen, M.E. Jan 1987. NTIS, PC A07/MF A01. File Number DE87005620.

In Semiconductor bridge (SCB) development technology transfer symposium.

Early observation of the SCB's success in igniting pyrotechnics prompted the consideration of several phenomena in an attempt to explain its observed efficiency. Clearly some energy transfer mechanism exists which effectively couples the bridge area to the adjacent explosive. Candidate contributors include: thermal conduction, thermal radiation, mechanical shock, photospecific excitation of the explosive, and convection from vaporized bridge products permeating the explosive. The effects of these energy transfer mechanisms are discussed.

25751 **(SAND—86-2366C) A new LIHE [Light Initiated High Explosive] test capability for spherical targets.** Benham, R.A. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 2p. (CONF-870398—1-Summ.). NTIS, PC A02/MF A01; GPO Dep. File Number DE87003035.

From Annual SDI technical achievements symposium; Washington, DC, USA (1 Mar 1987).

A goal of the Defense Nuclear Agency Lethality and Target Hardening (LTH-3) Program is to assess the lethality of the x-ray laser against the SDI threat entourage of boosters, post-boost vehicles (PBVs), reentry vehicles, and defense suppression weapons (DSWs). A principal characteristic of the effects of the x-ray laser on such threats is the delivery of a cosine distributed impulsive load to exposed curved surfaces of the targets. The LTH-3 program is using test and analysis techniques to investigate the structural response of models of typical targets and target components subjected to impulsive flood loads. A new capability for testing spherical targets using Light Initiated High Explosive (LIHE) is the subject of this paper. Spherical targets are of interest to LTH-3 since vulnerable pressurant, propellant, and chemical reactant storage vessels in PBVs and DSWs are likely to be generally spherical in design.

25752 **(UCRL—95555) The high pressure failure curve for JA2.** Costantino, M.; Ornellas, D. (Lawrence Livermore National Lab., CA (USA)). 10 Mar 1987. Contract W-7405-ENG-48. 10p. (CONF-870394—1). NTIS, PC A02. File Number DE87006820.

From Joint Army, Navy, NASA, Airforce propulsion systems hazards meeting; Huntsville, AL, USA (17 Mar 1987).

Data for the failure curve for the gun propellant JA2 is presented in this paper. The right circular cylinder sample is placed in a biaxial stress state by first applying a hydrostatic stress and then adding an axial stress. Keeping the hydrostatic stress constant at a confining pressure, $\sigma_2 = \sigma_3$, and increasing the axial stress, σ_1, generated an octahedral shear stress, $(\sigma_1\text{-}\sigma_3)/2$, which resulted in compressive failure. Four apparatus have been used to make these measurements over portions of the stress-strain rate space bounded by $0.1 < \sigma_2 = \sigma_3 < 400$ MPa and $10^{-4} < \epsilon < 10^3 s^{-1}$. All measurements were at room temperature. At $\epsilon = 10^{-4} s^{-1}$, the maximum octahedral shear stress at 3% axial strain increased from 2.3 MPa at a confining pressure of 0.1 MPa to 8.2 MPa at a confining pressure of 400 MPa. The slope of the linear portion of the stress-strain curve increased from 0.47 to 1.0 GPa over the same range. The failure mode at all confining pressures was ductile. Strain rate effects are significant, with the strength increasing by a factor of about four over strain rates from 10^{-4} to $10^3 s^{-1}$. As in previous results for a LOVA propellant, the strength increased with the confining pressure, with increasing slope. These data are used in calculations of the response of the gun propellant grains to stress during the interior ballistic cycle and in various hazards and vulnerability scenarios.

25753 **Fluctuations in combustion.** Nicolis, G.; Baras, F.; Mansour, M.M. (Universite Libre de Bruxelles, Belgium). pp 171-188 of Chemical instabilities. Nicolis, G.; Baras, F. (eds.). Hingham, MA; D. Reidel Publishing Company (1984). Contract AS05-81ER10947.

A stochastic description of explosion phenomena is set up, both for isothermal and for exothermic reaction mechanisms. Numerical simulations and analytic study of the master equation show the appearance of long tail and multiple humps in the probability distribution, which subsist for a certain period of time. During this interval the system displays chaotic behavior, reflecting the random character of the ignition process. An estimate of the onset time of transient bimodality is carried out in terms of the size of the system, the intrinsic parameters, and the initial condition. The implications of the results in combustion are discussed. 13 references, 9 figures.

25754 **Frictional hot-spots and propellant sensitivity.** Dienes, J.K. (Los Alamos National Lab., NM). *Materials Research Society Symposia Proceedings;* **24**: 373-381(1984).

When propellant cylinders are fired at low speeds against a steel plate, detonations are often observed. Since the process is not repeatable, and shock heating is not significant, it is natural to consider the possibility of detonation caused by hot spots. Several mechanisms are compared, and it is suggested that interfacial friction of closed cracks seems to be the most likely mechanism. 24 references.

4502 Nuclear

25755 **(AD-A—176200/4/XAB) Digitized pressure-time records, selected nuclear events. Technical report, 1 September 1982-1 April 1986.** McMullan, F.W.; Bryant, E.J. (Kaman Tempo, Santa Barbara, CA (USA)). 30 Apr 1986. 742p. (KT—86-009(R)). NTIS, PC A99/MF E04.

Pressure-time records are presented for selected atmospheric nuclear events. The records were extracted from published test reports, digitized, and given uniform pressure-time scales for a given event and a given range to permit easier comparison. Data include p-t, q-t, p(tot)-t, Mach No-t, and Impulse-t as appropriate. Selected data were scaled to 1 kT.

25756 **(NVO—307) Analysis of operation TEAPOT nuclear test ZUCCHINI radiological and meterological data.** Quinn, V.E. (National Oceanic and Atmospheric Administration, Las Vegas, NV (USA). Weather Service Nuclear Support Office). Mar 1987. Contract AI08-76DP00351. 92p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007529.

This report describes the Weather Service Nuclear Support Office (WSNSO) analyses of the radiological and meteorological data collected for the ZUCCHINI nuclear test of Operation TEAPOT. Inconsistencies in the radiological data and their resolution are discussed. The methods of normalizing the radiological data to a standard time and estimating fallout-arrival times are presented. The meteorological situations on event day and the following day are described. A comparison of the WSNSO fallout analysis with an analysis performed in the 1950's is presented. The radiological data used to derive the WSNSO 1986 fallout pattern are tabulated in an appendix.

25757 **(UCID—21012) Dynamics testing and modeling of NTS microwave tower.** Weaver, H.J.; Burdick, R.B.; Woehrle, T.G.; McCallen, D.B. (Lawrence Livermore National Lab., CA (USA)). 15 Jan 1987. Contract W-7405-ENG-48. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007519.

A dynamic evaluation of a typical NTS microwave tower was recently performed. This evaluation consisted of constructing a finite element model of the tower (using the GEMINI code). This model was then verified by performing a modal, or dynamic, test on the tower and then adjusting the finite element parameters so that the predicted resonant frequencies and mode shapes were in agreement with those actually measured. Based on the results of this dynamic evaluation it was found that the one of the modes of the guy wires coupled directly into the second mode of the microwave tower itself. In addition to this particular evaluation, this project has produced a "calibrated" finite element model of a typical NTS microwave tower that should be very useful in understanding the basic dynamics involved. Using this model, it is possible to predict the response motion and critical stresses in a tower when exposed to nuclear event ground motion.

25758 **(UCRL—15860-Vol.2) Contaminant transport during atmospheric pumping of a nuclear chimney: Progress report.** Nilson, R.H.; Peterson, E.W. (S-Cubed, La Jolla, CA (USA); Lawrence Livermore National Lab., CA (USA)). 1 Sep 1986. Contract W-7405-ENG-48. 51p. (SSS-R—86-7726). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006684.

Cyclical variations in barometric pressure cause an oscillatory up-and-down motion of gases within the chimney produced by an underground nuclear test. Analytical and experimental modeling of this atmospheric pumping mechanism has been undertaken to better understand and to quantify the associated rates of cavity gas migration toward the earth's surface and the probable rate of release to the atmosphere. Three different types of models are being investigated: (1) homogeneous porous medium; (2) fractured medium with impermeable matrix blocks; and (3) double-porosity media consisting of fracture networks among porous matrix blocks. A primary purpose is to understand how the oscillatory character of the atmospheric pumping process might significantly enhance the contaminant transport in any or all of the three classes of media. This preliminary report describes some of the analytical, numerical, and experimental work which have been completed.

25759 **(UCRL—92437) The role of calculations to define containment phenomenology in complex geology.** Swift, R.P.; Rambo, J.T.; Bryan, J.B. (Lawrence Livermore National Lab., CA (USA)). Oct 1985. Contract W-7405-ENG-48. 34p. (CONF-850953—23). NTIS, PC A03. File Number DE87008159.

From 3. symposium on containment of underground nuclear explosions; Idaho Falls, ID, USA (10 Sep 1985).

Containment evaluation of some underground nuclear events has become strongly dependent on the use of calculations to help define important phenomenology. This results from the increasing necessity to test in sites having a geology that precludes acceptance based solely on experience. This paper discusses the rationale of a suite of TENSOR code calculations undertaken in support of the containment evaluation for a recent event and highlights the results of these calculations. The calculations illustrate containment phenomena in a layered geology of alluvium and tuff with a working point in the proximity of the Paleozoic surface. They show that reflected disturbances from surfaces above and/or below the working point can significantly hinder the development of the residual stress field if their arrival in the residual stress region coincides with the rebound phase of cavity growth. In addition, the results demonstrate a need for the development of a criterion for the probability of successful containment in complex geology other than the historical concept of a strong, sufficiently thick residual stress field. 15 refs., 13 figs., 4 tabs.

25760 **(AD-A—176241/8/XAB) Effect of a nuclear explosion on antitank and antipersonnel mines.** Katurkin, Y. (Air Force Systems Command, Wright-Patterson AFB, OH (USA). Foreign Technology Div.). 7 Jan 1987. Translation of Voyenno-Inzhenenyhual(oynyVsi) (SSR), Vol. 102, No. 12, 42-44(1958). (FTD-ID(RS)T—1267-86). 11p. NTIS, PC A02/MF A01.

According to foreign press reports, the capitalist countries that currently have nuclear weapons, particularly the U.S., are conducting a variety of tests in connection with studies of the destructive effect of nuclear exposions on different types of fortifications, military hardware, and animals. An article appearing in the Swiss journal Technische Mitteilungen Fuer Sappeure, Pontoniere und Mineure (May 1958) contains data from tests on mines that permit qualitative analysis of the bahavior of a variety of antitank and antipersonnel mines under the effect of a nuclear explosion. This requires, first of all, knowledge of the magnitude of the pressure of the air shock wave, the intensity of the luminous radiation and, in part, data on the design of the mines. Of some importance in this connection are factors such as the nature of the surface and the physical characteristics of the soil, the method employed in laying the mines and so on, but these factors are not the most critical ones and so have only a negligible effect on the overall picture of the behavior of mines under the effect of a nuclear explosion. (Russian Translations).

4503 Explosion Detection

REFER ALSO TO CITATION(S) 24672

50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC

25761 **Modeling study on the fair weather marine boundary layer of the GATE.** Yamada, T.; Kao, C.h.J. (Earth and Space Science Division, Los Alamos National Laboratory, Los Alamos, NM 87545). *Journal of the Atmospheric Sciences;* **43**: No. 24, 3186-3199(15 Dec 1986).

A three-dimensional ensemble-mean mesoscale atmospheric model, with simplified second-moment turbulence closure equations and a statistical treatment for the condensation process, is used to stimulate a fair weather marine boundary layer observed during the GATE [GARP (Global Atmospheric Research Program) Atlantic Tropical Experiment]. The data deduced from airborne and surface-based instrumentation provided not only comprehensive initial and boundary conditions for the model but also permitted detailed comparisons between modeled and observed turbulence quantities.

5001 Basic Studies

REFER ALSO TO CITATION(S) 25780

25762 (CONF-8309248—, pp 48-57) **Residence and transport of pollutants in the atmosphere - a meteorological problem.** Dop, H. van. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

A review is given of some of the problems involved in modelling the transport of air pollution. The complicated atmospheric flow field inhibits an accurate determination of the fate of material released in the atmosphere. Some dynamical properties of the atmospheric boundary layer are explained.

25763 (DOE/ER/60269—1) Coordination for the OHER/ERD R4D program including provision for climatological services: Progress report, 1984-1985. Kelley, J.J. (Alaska Univ., Fairbanks (USA). Inst. of Marine Science). 24 Sep 1985. Contract FG06-84ER60269. 72p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87008177.

This project provides coordination in the field which is a service function for the R4D projects. It consists of (1) scheduling and logistics coordination services; (2) liaison services with industry, government and academic institutions; (3) technical services in the field as requested (climatology, atmospheric particulate input); and (4) acquisition of permits.

25764 (DOE/ER/60269—4) Coordination for the OHR/ERD R4D program: Progress report, July 1-December 31, 1986. Kelley, J.J. (Alaska Univ., Fairbanks (USA). Inst. of Marine Science). Oct 1986. Contract FG06-84ER60269. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008176.

This report covers the period of a six-month grant, July 1, to December 1986. The project provides coordination in the field for the R4D projects. It consists of (1) scheduling and logistics coordination services; (2) liaison services with industry, government and academic institutions; and (3) technical services in the field as requested (regional climatology, atmospheric particulate input).

25765 (DOE/ER/60269—5) Climatological observations in the Philip Smith Mountains of the North Slope, Alaska: Climatology report series No. 2. Kelley, J.J.; Foster, D. (Alaska Univ., Fairbanks (USA). Inst. of Marine Science). Oct 1986. Contract FG06-84ER60269. 348p. NTIS MF A01; 2; GPO Dep. File Number DE87008179.

Climatological data from an automatic weather station (Aanderaa) located at the Alyeska Pipeline Service Company Material Site 117 (MS-117) are presented in this report. Data are listed for hourly averages daily. The data report covers the period 1 August 1985 to 31 May 1986. Observations in this report include wind speed and direction, temperature and barometric pressure. Descriptions of the instrumentation and estimates of reliability are included in the test. Various analyses of the data are presented in the appendices. A summary of the wind and temperature regime is presented through displays of cumulative frequencies of hourly temperatures and wind speeds for the 12-month period, June 1985 to May 1986.

25766 (DOE/EV/10121—T3) Homogeneous and heterogeneous chemistry of atmospheric species: Progress report covering the period 1 March 1984 through 31 December 1984. Golden, D.M.; Barker, J.R.; Rossi, M.J. (SRI International, Menlo Park, CA (USA)). 4 Jan 1985. Contract AC03-78EV10121. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007747.

Our overall plan is (1) to continue our investigation of the homogeneous and heterogeneous interactions among water vapor, nitrogen dioxide, and sulfur dioxide by the methods developed previously with DOE support and (2) to attack the difficult measurement of the reaction rate constant for the reaction of methoxy radicals with oxygen. Experimental investigation of radical-radical disproportionation reactions will begin when the first two studies have been concluded.

25767 (EPRI-EA—5091-Vol.2) Modeling the polluted coastal urban environment: Volume 2, The dispersion model: Final report. Bornstein, R.; Pechinger, U.; Salvador, R.; Shieh, L.J.; Ludwig, F. (San Jose State Univ., CA (USA). Dept. of Meteorology; Electric Power Research Inst., Palo Alto, CA (USA)). Feb 1987. 124p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI87920283.

A three-dimensional Eulerian grid air pollution dispersion model was developed using meteorological parameters from a three-dimansional finite-difference planetary boundary layer (PBL) model. The PBL and dispersion models were used to simulate sulfur dioxide concentrations resulting from multiple area and point source emissions in New York City for a three-day period, during which a sea breeze front passed through the area. Predicted meteorological and concentration fields were compared with data collected during the period. Results from the initial simulations demonstrate that the dispersion model can correctly simulate most of the qualitative features of the observed time-varying three-dimensional surface and PBL sulfur dioxide concentration fields during periods with complex meteorological conditions associated with thermally generated mesoscale circulations. The model was somewhat less successful in accurately reproducing the values of the observed concentrations; however, most predicted concentration values were within a factor of two of corresponding observed values.

25768 (LA-UR—87-571) An atmospheric correction algorithm for remote identification of non-Lambertian surfaces and its range of validity. Gratzki, A.; Gerstl, S.A.W. (Los Alamos National Lab., NM (USA)). 20 Feb 1987. Contract W-7405-ENG-36. 6p. (CONF-870576—2). NTIS, PC A02. File Number DE87006059.

From IGARSS '87; Ann Arbor, MI, USA (18 May 1987).

The usefulness of remotely sensed surface data depends on the ability to correct for atmospheric pertubations on the image. An atmospheric correction algorithm has been proposed which removes atmospheric pertubations from off-nadir measured radiances at the top of the atmosphere in the visible and near-infrared wavelength region. The ability of the model to reproduce radiance distributions at the surface from radiances at the top of the atmosphere is tested and found to be better than 15%. The correction formalism requires as minimum information the total optical depth of the atmosphere and the surface albedo. In this study the accuracy of the model to assumptions about the aerosol phase function, the single-scattering albedo and the vertical profile of the optical depth is also tested.

25769 (RISO-R—233) Hot-wire measurements of atmospheric turbulence near the ground. Ejling Larsen, S. (Risoe National Lab., Roskilde (Denmark)). Oct 1986. 342p. NTIS (US Sales Only), PC A15/MF A01. File Number DE87751685.

A description is given of the instrumentation that was used by the meteorology group of Risoe National Laboratory during the Kansas 1968 experiment. The sensors consisted of hot-wires and a cold-wire mounted on a wind vane. The parametres measured were all components of the velocity plus the temperature or the total horizontal velocity. The data were recorded on an analogue recorder and analysed at Risoe by means of an analogue computer, providing mean values and second order moments together with power-, co- and quadrature spectra. The instrumentation system and the analysis are discussed. The results presented are mainly centered around display of the different non-idealities in instrument response and analysis schemes, and in comparing our results to the main set of results obtained during the experiment by the group from Air Force Cambridge Laboratories. However, the data set also yields independent information about the behaviour of power- co- and quadrature spectra in the atmospheric surface layer and about the dissipation of velocity and temperature vesus stability.

5002 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 24455, 24467, 24535, 24536, 24594, 24606, 24607, 24775, 24776, 24777, 24778, 24780, 25167, 25179, 25407, 25507, 25726, 25766, 25832, 25838, 25852, 25979, 25982, 25983, 25988, 25990, 25994

25770 (AD-A—176047/9/XAB) Marine aerosol characteristics in the subtropical north Atlantic and at North American coastal sites. Final report. Mack, E.J.; Rogers, C.W.; Wattle, B.J. (Calspan Corp., Buffalo, NY (USA)). Dec 1986. 122p. (CALSPAN—6890-M-1). NTIS, PC A06/MF A01.

Partial contents: A climatology of maritime aerosol populations, Aerosol characteristics of NRL-705-83 cruise - Overview of Aerosol Variability in the Atlantic along 20-30°N, General behavior of continental plumes over the oceans, Sea salt aerosol concentration vs. wind speed, and Sulfur over the ocean; A potential relationship between atmospheric aerosol optical depth and boundary-layer visibility; Appendices - Aerosol data for Corea, Maine, July 1981, Aerosol data for Valkaria, Florida, July 1982, and Drop size distributions for NRL-705-83 Cruise, 11 Mar - 17 April 1983.

25771 (BNL—38985) Accommodation coefficients of ozone and sulfur dioxide: Their implications on SO_2 oxidation in cloud water. Tang, I.N.; Lee, J.H. (Brookhaven National Lab., Upton, NY (USA)). May 1986. Contract AC02-76CH00016. 13p. (CONF-860425—40). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003484.

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

Interfacial mass transfer of trace gases into aqueous phase is investigated in a UV absorption-stop flow apparatus. For the first time, the mass accommodation coefficients are determined for O_3 (5.3 x 10^{-4}) and for SO_2 (>2 x 10^{-2}). The results are incorporated into a simple model considering the coupled interfacial mass transfer and aqueous chemistry in cloud drops. It is shown that dissolution of O_3 into a drop is fast compared with its subsequent oxidation of dissolved SO_2. In addition, the conversion rate of S(IV) to S(VI) in aqueous drops by ozone reactions is not limited by interfacial resistance.

25772 (BNL—39205) Public health issues in photovoltaic energy systems: An overview of concerns. Moskowitz, P.D.; Fthenakis, V.M.; Hamilton, L.D.; Lee, J.C. (Brookhaven National Lab., Upton, NY (USA)). Jan 1986. Contract AC02-76CH00016. 19p. (CONF-8601110—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007643.

From SERI photovoltaics safety conference; Lakewood, CO, USA (16 Jan 1986).

Photovoltaic cell fabrication facilities may adversely affect public health by emitting pollutants during routine operation or by accidental events. The most important hazards probably relate to accidental releases of toxic or flammable gases used in large quantities in thin-film photovoltaic cell production. The most efficient strategies for reducing gas risks is to choose material and process options which inherently possess small risks, and to prevent accident initiating events. If accidents do occur, strategies to prevent catastrophic releases, to control releases and to prevent public exposures to toxic agents become important. Prevention and mitigation of consequences form the final defensive barriers. Homeowners who have small decentralized arrays may be at increased risk to fire and electric shock hazards. Manufacturers should carefully consider design engineering measures to prevent events, to prevent exposures, and to prevent consequences. If industry approaches these issues and mitigation strategies in a systematic way, liability and risk to industry and to the public should be minimized. 18 refs., 1 fig., 5 tabs.

25773 (CONF-861158—11) An economic incentives approach for reducing acid rain. Veselka, T.D.; Streets, D.G. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 11p. NTIS MF A01; 2; GPO Dep. File Number DE87006981.

From 8. North American International Association of Energy Economists conference: changing world energy economy; Cambridge, MA, USA (19 Nov 1986).

Proposed strategies for reducing the adverse effects of acid deposition have centered on controlling sulfur dioxide emissions from coal-fired utility power plants. Many prescriptions for reducing such emissions have been offered in the past five years, and almost all of them are of the standards-plus-enforcement type. We have examined an alternative approach: economic incentives for emission reductions. The inspiration for this work came from a bill (H.R. 4483) introduced to the 98th Congress in 1983 by Rep. Les Aspin of Wisconsin. Of the 50 bills introduced between 1981 and 1985, this was the only one to propose an economic incentives approach to acid-rain control. With the development of detailed models and data bases of the electric utility industry, it is possible to examine the likely effects of a program such as that proposed by the Aspin bill.

25774 (CONF-8309248—) Acid deposition - a challenge for Europe. Proceedings. Preliminary edition. Ott, H.; Stangl, H. (eds.). (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.); Commission of the European Communities, Brussels (Belgium); Commission of the European Communities, Ispra (Italy). Joint Research Centre). 1983. 424p. (In German, English and French). NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

The symposium comprised the three sections: Origin, transport, conversion and deposition of air pollutants; effects of air pollution and acid deposition; abatement strategies. Separate abstracts are available for 14 of the 19 papers.

25775 (CONF-8309248—, pp 33-47) **Air pollution, emission and ambient concentrations.** Ottar, B. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

The amounts of atmospheric contaminants released by fuel combustion, industrial production and the extensive use of chemicals make it necessary to consider seriously the capacity of the atmosphere and our environment to receive the various components without substantial adverse effects. Emissions, observed concentrations and some characteristics of the regional air pollution in Europe are discussed in relation to the acidification of the precipitation and the occurance of photochemical oxydants. Also the emissions of volatile hydrocarbons, halogenated hydrocarbons and trace elements are considered. Today the technical means needed to examine the relations between emissions and measured concentrations as a basis for evaluation of regional air pollution hazards are available, but many countries are still unable to provide the necessary information on emissions and to undertake the necessary air pollution measurements.

25776 (CONF-8309248—, pp 58-81) **Formation of atmospheric acidity.** Cox, R.A.; Penkett, S.A. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

Atmospheric oxidation is a natural process which is largely driven by photochemistry. In the case of oxides of nitrogen and sulphur emitted from the combustion of fossil fuels, oxidation leads to the formation of strong acids which cause acidification of rain in areas far removed from their source. The mechanisms of the various oxidation processes are dealt with in this paper. They can occur in the gas phase, in liquid droplets or possibly on the surface of some aerosol particles. They are very complex and involve free radicals, such as the hydroxyl radical, strong oxidant molecules, such as ozone and hydrogen peroxide and transition metal catalysts.

25777 (CONF-8309248—, pp 186-192) **Acidification of the environment: A Canadian perspective.** Martin, H.C. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

This paper presents an overview of the research which has been undertaken in Canada over the past several years as well as research currently underway. The specific areas of study which will be described include atmospheric processes, aquatic effects, terrestrial effects, and the development of an environmental target for protection of aquatic ecosystems. The paper will also briefly describe control activities and policies implemented in Canada to address the acidification problem.

25778 (CONF-8309248—, pp 193-226) **Effects of primary and secondary air pollutants and acid depositions on (ancient and modern) buildings and monuments.** Skoulikidis, Th.N. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

The acceleration of corrosion of Zn, Al, Cu, Pb, Fe(steel) and concrete rebars from atmospheric pollutants is reported; especially the depassivation of galvanised steel from SO/sub 2/ for Greece and England, as well as a comparison of the corrosion of concrete rebars in clean and polluted air are presented. The direct and indirect effects of SO/sub 2/, NO/sub x/, HCl, suspended particles, CO/sub 2/, H/sub 2/SO/sub 4/, HNO/sub 3/, O/sub 3/ and microorganisms on the deterioration of calcites and marbles are also presented; especially the mechanism of sulfation, the results of the use of 'protective coatings' in Europe and the design of their protective properties are reported.

25779 **(DOE/PC/81008—T7) Direct sorbent injection for combined SO_2NO/sub x/ removal: Quarterly technical progress report, October-December 1986.** Dowdy, T.E.; Henry, J.M.; Holt, J.K.; Lee, J.J.; Smith, J.R. (Tennessee Univ., Tullahoma (USA). Space Inst.). Apr 1987. Contract AC22-85PC81008. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007682.

During the reporting period, installation, calibration and debugging of the Direct Sorbent Injection test facility has been carried out and gas absorption testing is now underway. The time required to complete checkout and debugging was considerably longer than planned. Drying rate experiments were completed and are summarized. Data acquisition and analysis procedures were established. Computer assisted modelling is proceeding.

25780 **(ECN—86-176) Effective removal parameters in long-range air pollution transport models.** Janssen, A.J.; Asman, W.A. (Netherlands Energy Research Foundation, Petten). Jan 1987. 28p. ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

In simple Lagrangian long-range transport models used for air pollution studies turbulant mixing is described in a very approximate way. This description has the effect that calculated concentrations and deposition patterns may not be realistic. However, correction factors, derived from more detailed diffusion theory calculations, can be introduced easily into these simple models so that an adequate account of the mixing process is taken. If such correction factors are applied in simple models, the increase in computing time is negligible, whereas the results are about as good as those of more sophisticated models which need much more computing time. This paper describes how the necessary correction factors can be put into a simple model and how a reactive diffusion model is used to derive the values of these factors. Calculated values are given for the pollutants NH/sub 3/, SO/sub 2/ and NO/sub x/ and for their reaction products NH/sup +//sub 4/, SO/sup 2-//sub 4/ and NO/sup -//sub 3/, respectively. Sensitivety calculations are made and results are compared with the results of other diffusion models. 2 figs., 3 tabs., 10 refs.

25781 **(GKSS—86/E/44) Distribution of hydrogen chloride in plumes of incineration ships: Remote measurements of concentration distributions and determination and degradation parameters.** Heinrich, H.-J.; Eck, I.; Weitkamp, C. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). 1986. 161p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE87751727.

Remote measurements of the space-resolved concentration distribution of hydrogen chloride and aerosol in plumes of incineration ships are reported that destroy chlorinated hydrocarbon waste in the North Sea. From the data dilution and degradation parameters of HCl are determined. The importance of different processes responsible for the removal of HCl from the marine atmosphere is assessed. The present paper covers measurements made with a DF lidar from board the research ship Oceanworker in plumes of incinerators Vesta and Vulcanus II between August and October 1983. With 102 figs., 15 tabs.

25782 **(N—87-12059) Development of data processing, interpretation and analysis system for remote sensing of trace atmospheric gas species. Final report, period ending June 1986.** Gormsen, B.B.; Tiwari, S.N. (Old Dominion Univ., Norfolk, VA (USA)). Aug 1986. 9p. (NASA-CR—179882; NAS—1.26:179882). NTIS, PC A02/MF A01.

Highly efficient methods were developed for the analysis and reduction of Measurement of Air Pollution from Satellite (MAPS) data. Specific attention was directed to analyzing the data from the Office of Space and Terrestrial Applications 3 (OSTA-3) correlative measurements of aircraft research flights and from the OSTA-3 shuttle flight. Methods were developed for error analysis of the aircraft and spacecraft instruments. The LSI 11/23 software system was modified and expanded for future data analysis.

25783 **(N—87-13022) Description of data on the Nimbus 7 LIMS map archive tape: ozone and nitric acid.** Remsberg, E.E.; Kurzeja, R.J.; Haggard, K.V.; Russell, J.M. III; Gordley, L.L. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Dec 1986. 73p. (NASA-TP—2625; L—16136; NAS—1.60:2625). NTIS, PC A04/MF A01.

The Nimbus 7 Limb infrared monitor of the stratosphere (LIMS) data set has been processed into a Fourier coefficient representation with a Kalman filter algorithm applied to profile data at individual latitudes and pressure levels. The algorithm produces synoptic data at noon Greenwich Mean Time (GMT) from the asynoptic orbital profiles. This form of the data set is easy to use and is appropriate for time series analysis and further data manipulation and display. Ozone and nitric acid results are grouped together in this report because the LIMS vertical field of views (FOV's) and analysis characteristics for these species are similar. A comparison of the orbital input data with mixing ratios derived from Kalman filter coefficients indicates errors in mixing ratio of generally less than 5 percent, with 15 percent being a maximum error. The high quality of the mapped data was indicated by coherence of both the phases and the amplitudes of waves with latitude and pressure. Examples of the mapped fields are presented, and details are given concerning the importance of diurnal variations, the removal of polar stratospheric cloud signatures, and the interpretation of bias effects in the data near the tops of profiles.

25784 (N—87-16742, pp vp) **In search of stratospheric bromine oxide.** Lestrade, J.P. Nov 1986. NTIS, PC A99/MF E04. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—).

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

The Imaging Spectrometric Observatory (ISO) is capable of recording spectra in the wavelength range of 200 to 12000 Angstroms. Data from a recent Spacelab 1 ATLAS mission has imaged the terrestrial airglow at tangent ray heights of 90 and 150 km. These data contain information about trace atmospheric constituents such as bromine oxide (BrO), hydroxyl (OH), and chlorine dioxide (OClO). The abundances of these species are critical to stratospheric models of catalytic ozone destruction. Heretofore, very few observations were made especially for BrO. Software was developed to purge unwanted solar features from the airglow spectra. The next step is a measure of the strength of the emission features for BrO. The final analysis will yield the scale height of this important compound.

25785 **(NILU-OR—59/85) On air pollution transport to the Norwegian Artic.** Iversen, T. (Norsk Inst. for Luftforskning, Lillestroem). Oct 1985. 71p. NTIS (US Sales Only), MF A01. File Number DE87751708.

A research program has been performed to investigate the state of air pollution in the Norwegian Artic, and its possible sources. Sulphate concentrations at ground level on Bear Island and Ny Aalesund have been measured on a regular basis since 24 August 1979, and the analysis cover the period until 31 August 1984. Mean values and variances of the concentrations of the air pollutants show an annual cycle which coincide well with the seasonal variation of large-scale quasi-stationary atmospheric flows. The episodic behavior of air pollution is well explained by the occurence of quasi-stationary poleward transport of air during the cold season. The very small variations in pollutant concentrations during summer is very little influenced by long-range transport of air. On the whole, the large-scale quasi-stationary atmospheric flows, brought about by very long planetary waves, are the basic mechanisms that provides conditions for long-range transport of air pollutants from mid- to polar-latitudes into the Norwegian Arctic. The residence times of pollutants, once brought into the Arctic, seem to be much longer during the cold than during the warm season. There is a certain background level of air pollution during the cold season, which is effectively removed during late spring. It remains low throughout summer and most of autumn, and increases gradually in the late autumn or early winter. 37 figures, 2 tables.

25786 (ORNL/TM—10341) Evaluation of selected detector systems for products formed in the atmospheric hydrolysis of uranium hexafluoride. Bostick, W.D.; Bostick, D.T. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007800.

Sensitive detection of UF_6 hydrolysis products, either by discontinuous sampling or by continuous or near real-time monitoring, is an important safety consideration for DOE contractors handling large quantities of UF_6. Automated continuous or rapid intermittent remote sensing of these reaction products can provide an alarm signal when a preselected threshold value has been exceeded (absolute response) or when a significant emission excursion has occurred (rate of change of response). This report evaluates the performance of selected devices for the detection of airborne materials formed in the release of liquid UF_6 (≅1.3 g) into an enclosed volume of 6 m^3; these experiments were initiated on October 23, 1986. The detection principles investigated are: photometric, gas detector tubes, and electrochemical sensor.

25787 (PB—87-128849/XAB) Illinois State Implementation Plan for air-pollution control. An air-quality analysis of the State Implementation Plan for sulfur dioxide in the Alton-Wood River area of Madison County. Final report. (Illinois Environmental Protection Agency, Springfield (USA). Div. of Air Pollution Control). Jun 1986. 52p. (IEPA/APC—86-019). NTIS, PC A04/MF A01.

Errata sheet inserted.

The National Institute for Occupational Safety and Health (NIOSH) has developed two data files, the Registry of Toxic Effects of Chemical Substances (RTECS) and the National Occupational Hazard Survey (NOHS), which contain data on chemical toxicity and worker exposure to chemicals. A technique for objectively assessing the potential health risk due to chemical exposure in the workplace is described. Computer algorithms used to combine information in NIOSH data files to rank-order chemicals by considering toxicologic properties and number of workers exposed are discussed. Their use in producing indices of the potential health risk encountered by workers in specific industries and occupations arising from chemical exposure are described. Five indices are identified and appropriate algorithms are defined with examples of typical index pages.

25788 (PB—87-135307/XAB) Health-hazard evaluation determination report no. HETA 80-101-9001, Jones and Laughlin Steel Corporation, Vesta No. 5, general machine shop, Mine ID No. 3600960, Fredericksburg, PA. Final report. (National Inst. for Occupational Safety and Health, Morgantown, WV (USA)). 1982. 28p. (MHETA—80-101-9001). NTIS, PC A03/MF A01.

Worker exposure to toxic metal fumes, flux fumes, and gases generated during routine welding and cutting operations was studied. The investigation was requested by the United Mine Workers of America and was performed on November 14 and 15, 1979. The study was prompted by worker concern over a possible excess of mortality among welders in the shop. A total of 17 welders and one blacksmith worked in the welding shop. Some welders were exposed to inorganic nickel in concentrations higher than the NIOSH recommended standard of 15 micrograms per cubic meter (mg/cu m). Most of the welders were exposed to hexavalent chromium in concentrations above the American Conference of Governmental Industrial Hygienists standard of 0.5 mg/cu m. Three of five 15-minute personal samples exceeded the NIOSH recommended limit of 1.8 mg/cu m for nitrogen-dioxide. It was concluded that there was significant overexposure to nickel, hexavalent chromium, and nitrogen dioxide. Recommendations were made.

25789 (PB—87-140943/XAB) Comprehensive field study plan to relate pollutant sources to acidic deposition: a preliminary study of uncertainties. Final report. Stewart, D.A.; Langstaff, J.E.; McNaughton, D.J.; Bowne, N.E.; Kaleel, R. (TRC Environmental Consultants, Inc., East Hartford, CT (USA)). Dec 1986. 225p. NTIS, PC A10/MF A01.

See also PB—87-140950.

An experimental program was designed to empirically relate acidic deposition to precursor emissions. Preliminary estimates of uncertainty were made in order to assess confidence in the experimental design. The five general areas studied include uncertainties in measurements, local-scale data analyses, regional-scale data analyses, model simulations, and data analyses for regional experiments. Measurement uncertainties are large compared to deposition losses for gases on the local scale. On a regional scale, the existing ambient sulfate measurements network has a resolution of order 500 km, which is adequate, but characteristic spacing of SO_2 patterns requires resolution of less than 100 km. Model simulations indicated the frequency of tracer detectability at a receptor from a specific source is small and limited by meteorology. Also, the frequency of detectability is dependent on source strength. Local source modulations were modeled, and attainable modulation signals were found to be of insufficient magnitude to be detected over background concentrations when measurement uncertainties were considered. Results from these analyses of the effects of uncertainty were considered in the final experimental design.

25790 (PB—87-142337/XAB) Evaluation of short-term long-range transport models. Volume 1. Analysis procedures and results. Final report. Policastro, A.J.; Wastag, M.; Coke, L.; Carhart, R.A.; Dunn, W.E. (Argonne National Lab., IL (USA)). Oct 1986. 224p. NTIS, PC A10/MF A01.

See also Volume 2, Appendices A-E, PB—87-142345.

Eight short-term long-range transport models (MESOPUFF, MESOPLUME, MSPUFF, MESOPUFF II, MTDDIS, ARRPA, RADM, and RTM-II) were evaluated with field data from two data bases involving tracer releases. The primary quantitative means of evaluating model performance was the use of the American Meteorological Society statistics. Supplementary measures included the use of isopleth plots of ground-level concentrations, scatter plots, cumulative frequency distributions, and frequency histograms of residuals. General features of the model performance included: (a) spatial offset of predicted and observed patterns, (b) a time difference between the arrival of the predicted and observed plumes at a particular receptor, and (c) an angular offset of as much as 20-45 degrees between predicted and observed plumes.

25791 (PB—87-142345/XAB) Evaluation of short-term long-range transport models. Volume 2. Appendices A through E. Final report. Policastro, A.J.; Wastag, M.; Coke, L.; Carhart, R.A.; Dunn, W.E. (Argonne National Lab., IL (USA)). Oct 1986. 293p. NTIS, PC A13/MF A01.

See also Volume 1, PB—87-142337.

Eight short-term long-range transport models (MESOPUFF, MESOPLUME, MSPUFF, MESOPUFF II, MTDDIS, ARRPA, RADM, and RTM-II) were evaluated with field data from two data bases involving tracer releases. The primary quantitative means of evaluating model performance was the use of the American Meteorological Society statistics. Supplementary measures included the use of isopleth plots of ground-level concentrations, scatter plots, cumulative frequency distributions, and frequency histograms of residuals. General features of the model performance included: (a) spatial offset of predicted and observed patterns, (b) a time difference between the arrival of the predicted and observed plumes at a particular receptor, and (c) an angular offset of as much as 20-45 degrees between predicted and observed plumes.

25792 (PB—87-142378/XAB) Air quality criteria for lead. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Jun 1986. 1465p. NTIS, PC PC E99.

Set includes PB—87-142386 through PB—87-142410, and PB—85-163996.

No abstract available.

25793 (PB—87-142386/XAB) Air-quality criteria for lead. Volume 1. Final draft report. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Jun 1986. 274p. (EPA—600/8-83/028AF). NTIS, PC A12/MF A01.

See also Volume 2, PB—87-142394; Also available in set of 4 reports PC E99, PB—87-142378.

The document evaluates and assesses scientific information on the health and welfare effects associated with exposure to various concentrations of lead in ambient air. The literature through 1985 was reviewed thoroughly for information relevant to air-quality criteria, although the document is not intended as a complete and detailed review of all literature pertaining to lead. An attempt was made to identify the major discrepancies in our current knowledge and understanding of the effects of these pollutants. Although this document is principally concerned with the health and welfare effects of lead, other scientific data are presented and evaluated in order to provide a better understanding of the pollutant in the environment. To the end, the document includes chapters that discuss: the chemistry and physics of the pollutant; analytical levels; atmospheric chemistry and dispersion modeling; effects on vegetation; and respiratory, physiological, toxicological, clinical, and epidemiological aspects of human exposure.

25794 (PB—87-142394/XAB) Air-quality criteria for lead. Volume 2. Final draft report. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Jun 1986. 342p. (EPA—600/8-83/028BF). NTIS, PC A15/MF A01.

See also Volume 1, PB—87-142386, and Volume 3, PB—87-142402; Also available in set of 4 reports PC E99, PB—87-142378.

The document evaluates and assesses scientific information on the health and welfare effects associated with exposure to various concentrations of lead in ambient air. The literature through 1985 was reviewed thoroughly for information relevant to air-quality criteria, although the document is not intended as a complete and detailed review of all literature pertaining to lead. An attempt was made to identify the major discrepancies in the authors current knowledge and understanding of the effects of these pollutants. Although this document is principally concerned with the health and welfare effects of lead, other scientific data are presented and evaluated in order to provide a better understanding of this pollutant in the environment. To this end, the document includes chapters that discuss: the chemistry and physics of the pollutant; analytical levels; atmospheric chemistry and dispersion modeling; effects on vegetation; and respiratory, physiological, toxicological, clinical, and epidemiological aspects of human exposure.

25795 (PB—87-142402/XAB) Air-quality criteria for lead. Volume 3. Final draft report. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Jun 1986. 395p. (EPA—600/8-83/028CF). NTIS, PC A17/MF A01.

See also Volume 2, PB—87-142394, and Volume 4, PB—87-142410.\; Also available in set of 4 reports PC E99, PB—87-142378.

The document evaluates and assesses scientific information on the health and welfare effects associated with exposure to various concentrations of lead in ambient air. The literature through 1985 was reviewed thoroughly for information relevant to air-quality criteria, although the document is not intended as a complete and detailed review of all literature pertaining to lead. An attempt was made to identify the major discrepancies in the authors current knowledge and understanding of the effects of these pollutants. Although this document is principally concerned with the health and welfare effects of lead, other scientific data are presented and evaluated in order to provide a better understanding of the pollutant in the environment. To this end, the document includes chapters that discuss: the chemistry and physics of the pollutant; analytical levels; atmospheric chemistry and dispersion modeling; effects on vegetation; and respiratory, physiological, toxicological, clinical, and epidemiological aspects of human exposure.

25796 (PB—87-142410/XAB) Air-quality criteria for lead. Volume 4. Final draft report. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Jun 1986. 454p. (EPA—600/8-83/028DF). NTIS, PC A20/MF A01.

See also Volume 3, PB—87-142402; Also available in set of 4 reports PC E99, PB—87-142378.

The document evaluates and assesses scientific information on the health and welfare effects associated with exposure to various concentrations of lead in ambient air. The literature through 1985 was reviewed thoroughly for information relevant to air quality criteria, although the document is not intended as a complete and detailed review of all literature pertaining to lead. An attempt was made to identify the major discrepancies in the authors current knowledge and understanding of the effects of these pollutants. Although this document is principally concerned with the health and welfare effects of lead, other scientific data are presented and evaluated in order to provide a better understanding of the pollutant in the environment. To the end, the document includes chapters that discuss: the chemistry and physics of the pollutant; analytical levels; atmospheric chemistry and dispersion modeling; effects on vegetation; and respiratory, physiological, toxicological, clinical, and epidemiological aspects of human exposure.

25797 (PB—87-142949/XAB) Air-quality criteria for ozone and other photochemical oxidants. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Aug 1986. 1825p. NTIS, PC PC E99.

Set includes PB—87-142956 through PB—87-142998, and PB—85-126027.

No abstract available.

25798 (PB—87-142956/XAB) Air-quality criteria for ozone and other photochemical oxidants. Volume 1. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Aug 1986. 260p. (EPA—600/8-84-020AF). NTIS, PC A12/MF A01.

See also Volume 2, PB—87-142964; Also available in set of 5 reports PC 99, PB—87-142949.

Selected scientific information through early 1986 is presented and evaluated relative to the health and welfare effects associated with exposure to ozone and other photochemical oxidants. Data on health and welfare effects are emphasized; additional information is provided for understanding the oxidant pollution problem, for evaluating the reliability of effects data, and for assessing effects data relative to concentration occurring in ambient air. Information is also presented on exposure-related topics: sources, measurement, and concentrations of oxidant precursors; formation and transport of ozone and other photochemical oxidants; properties, chemistry, and measurement of ozone and other photochemical oxidants; and the concentrations of ozone and other photochemical oxidants typically found in ambient air. The specific areas addressed by chapters on health and welfare effects are the toxicological appraisal of effects of ozone and other oxidants; effects observed in controlled human exposures; effects observed in field and empidemiological studies; and effects on vegetation, natural and agroecosystems, and nonbiological materials.

25799 (PB—87-142964/XAB) Air-quality criteria for ozone and other photochemical oxidants. Volume 2. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Aug 1986. 446p. (EPA—600/8-84/020BF). NTIS, PC A19/MF A01.

See also Volume 1, PB—87-142956, and Volume 3, PB—87-142972.\; Also available in set of 5 reports PC 99, PB—87-142949.

Selected scientific information through early 1986 is presented and evaluated relative to the health and welfare effects associated with exposure to ozone and other photochemical oxidants. Data on health and welfare effects are emphasized; additional information is provided for understanding the oxidant pollution problem, for evaluating the reliability of effects data, and for assessing effects data relative to concentration occurring in ambient air. Information is also presented on exposure-related topics: sources, measurement, and concentrations of oxidant precursors; formation and transport of ozone and other photochemical oxidants; properties, chemistry, and measurement of ozone and other photochemical oxidants; and the concentrations of ozone and other photochemical oxidants typically found in ambient air. The specific areas addressed by chapters on health and welfare effects are the toxicological appraisal of effects of ozone and other oxidants; effects observed in controlled human exposures; effects observed in field and epidemiological studies; and effects on vegetation, natural and agroecosystems, and nonbiological materials.

25800 (PB—87-142972/XAB) Air-quality criteria for ozone and other photochemical oxidants. Volume 3. Draft final. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Aug 1986. 458p. (EPA—600/8-84/020CF). NTIS, PC A20/MF A01.

See also Volume 2, PB—87-142964, and Volume 4, PB—87-142980.\; Also available in set of 5 reports PC E99, PB—87-142949.

Selected scientific information through early 1985 is presented and evaluated relative to the health and welfare effects associated with exposure to ozone and other photochemical oxidants. Data on health and welfare effects are emphasized; additional information is provided for understanding the oxidant pollution problem, for evaluating the reliability of effects data, and for assessing effects data relative to concentration occurring in ambient air. Information is also presented on exposure-related topics: sources, measurement, and concentrations of oxidant precursors; formation and transport of ozone and other photochemical oxidants; properties, chemistry, and measurement of ozone and other photochemical oxidants; and the concentrations of ozone and other photochemical oxidants typically found in ambient air. The specific areas addressed by chapters on health and welfare effects are the toxicological appraisal of effects of ozone and other oxidants; effects observed in controlled human exposures; effects observed in field and eipdemiological studies; and effects on vegetation, natural and agroecosystems, and nonbiological materials.

25801 (PB—87-142980/XAB) Air-quality criteria for ozone and other photochemical oxidants. Volume 4. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Aug 1986. 333p. (EPA—600/8-84/020DF). NTIS, PC A15/MF A01.

See also Volume 3, PB—87-142972, and Volume 5, PB—87-142998.\; Also available in set of 5 reports PC E99, PB—87-142949.

Selected scientific information through early 1985 is presented and evaluated relative to the health and welfare effects associated with exposure to ozone and other photochemical oxidants. Data on health and welfare effects are emphasized; additional information is provided for understanding the oxidant pollution problem, for evaluating the reliability of effects data, and for assessing effects data relative to concentration occurring in ambient air. Information is also presented on exposure-related topics: sources, measurement, and concentrations of oxidant precursors; formation and transport of ozone and other photochemical oxidants; properties, chemistry, and measurement of ozone and other photochemical oxidants; and the concentrations of ozone and other photochemical oxidants typically found in ambient air. The specific areas addressed by chapters on health and welfare effects are the toxicological appraisal of effects of ozone and other oxidants; effects observed in controlled human exposures; effects observed in field and epidemiological studies; and effects on vegetation, natural and agroecosystems, and nonbiological materials.

25802 (PB—87-142998/XAB) Air-quality criteria for ozone and other photochemical oxidants. Volume 5. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Aug 1986. 328p. (EPA—600/8-84/020EF). NTIS, PC A15/MF A01.

See also Volume 4, PB—87-142980; Also available in set of 5 reports PC E99, PB—87-142949.

Selected scientific information through early 1986 is presented and evaluated relative to the health and welfare effects associated with exposure to ozone and other photochemical oxidants. Data on health and welfare effects are emphasized; additional information is provided for understanding the oxidant pollution problem, for evaluating the reliability of effects data, and for assessing effects data relative to concentrations occurring in ambient air. Information is also presented on exposure-related topics: sources, measurment, and concentrations of oxidant precursors; formation and transport of ozone and other photochemical oxidants; properties, chemistry, and measurement of ozone and other photochemical oxidants; and the concentrations of ozone and other photochemical oxidants typically found in ambient air. The specific areas addressed by chapters on health and welfare effects are the toxicological appraisal of effects of ozone and other oxidants; effects observed in controlled human exposures; effects observed in field and epidemiological studies; and effects on vegetation, natural and agroecosystems, and nonbiological materials.

25803 (PB—87-145280/XAB) Further studies of parameterized air-quality modeling methods for materials damage assessment. Final report. Dupuis, L.R.; Lipfert, F.W.; Peters, J.W. (Brookhaven National Lab., Upton, NY (USA)). Jan 1987. 55p. NTIS, PC A04/MF A01.

Damage to materials is one of the concerns of the National Acid Precipitation Assessment Program (NAPAP). The project addressed the concern by providing an inexpensive method for estimating the deposition of hydrogen ions and sulfur dioxide on spatial scales compatible with materials distributions within urban areas. Since monitoring data are taken at only a few discrete points within any urban area the direct use of such data was rejected as unsuitable for meeting the concern. Comparison of output from the Parameterized Air Quality Model Annual (PAQMAN) developed earlier in this project shows that the model values are generally within a factor of two of the observations. The model is sensitive to the size of the emissions grid cells especially in the 1 to 2 km size range. The most suitable use for PAQMAN is as a rapid screening technique for examining the effect of thousands of point sources of sulfur dioxide across an extensive region. Some of the automated procedures developed for PAQMAN have wider application.

25804 (PB—87-145298/XAB) Validation data for photochemical mechanisms. Final report, May 1984-April 1986. Sexton, K.G.; Jeffries, H.E.; Arnold, J.R.; Kale, T.L.; Kamens, R.M. (North Carolina Univ., Chapel Hill (USA). Dept. of Environmental Sciences and Engineering). Jan 1987. 307p. NTIS, PC A14/MF A01.

The report describes the quality-assurance and data-processing procedures and systems used at the UNC outdoor smog chamber facility. The facility is used to measure the reactants and products that participate in the photochemical smog formation process. The intent of the quality-assurance effort is to insure the collection, transfer, processing and reporting of accurate, high-resolution data without loss or distortion. The document describes the calibration techniques and data-processing procedures and the processing of the experimental data. A description and examples of the format of the final documentation and data file are given. Also included are the quality-assurance steps and accuracy and precision aspects of the data.

25805 (PB—87-145306/XAB) Atmospheric persistence of eight air toxics. Final report. Cupitt, L.T. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Jan 1987. 66p. (EPA—600/3-87/004). NTIS, PC A04/MF A01.

Atmospheric lifetimes were estimated for eight air toxic chemicals (i.e., methylene chloride, chloroform, carbon tetrachloride, ethylene dichloride, trichloroethylene, perchloroethylene, 1,3-butadiene, and ethylene oxide). Seven of the eight chemicals were removed from the atmosphere primarily by reaction with OH radicals. Recommendations were made for the average conditions to use in estimating the lifetime of air toxics over the continental U.S. due to OH reactions. These conditions were then applied to the designated air toxics to derive estimates of the average atmospheric lifetimes. Lifetimes of the seven chemicals primarily removed by OH reaction ranged from around 4 hours to around 18 months. In the case of eighth chemical, carbon tetrachloride, the primary removal mechanism is unknown. Carbon tetrachloride has a very long atmospheric lifetime, estimated in the literature as around 50 years.

25806 (PB—87-145363/XAB) PTPLU - a single-source Gaussian dispersion algorithm. Addendum. Pierce, T.E. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Dec 1986. 18p. (EPA—600/8-86/042). NTIS, PC A02/MF A01.

See also report dated Aug 82, PB—83-211235.

PTPLU has been modified to include urban dispersion coefficients, urban wind-profile exponents, and a default option. This modification has resulted in PTPLU - Version 2.0. This document briefly describes the modifications to PTPLU and presents a test case.

25807 (PB—87-145397/XAB) Estimation of uncertainty for the 1980 NAPAP (National Acid Precipitation Assessment Program) emissions inventory. Final report, October 1985-October 1986. Langstaff, J.E.; Wagner, J.K. (Alliance Technologies Corp., Bedford, MA (USA)). Dec 1986. 51p. (GCA-TR—85-96-G). NTIS, PC A04/MF A01.

The report presents the methods, assumptions, and results of an effort to develop quantitative estimates of emissions uncertainties for the 1980 National Acid Precipitation Assessment Program (NAPAP) Emissions Inventory. Conventional statistical concepts were applied to sample uncertainty data. Results of this study consist of lessons learned and problems identified, and fall into three categories: uncertainty relationships at various levels of emissions disaggregation, statistical methodology questions, and gaps in input data. The computed uncertainty values are illustrative in nature and included for completeness; these values may be used only to identify uncertainty trends and relationships between the various pollutants at increasing levels of aggregation and allocation.

25808 (PB—87-145447/XAB) Precision and accuracy assessments for state and local air monitoring networks, 1985. Rhodes, R.C.; Evans, E.G. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Monitoring and Systems Lab.). Jan 1987. 257p. (EPA—600/4-87/003). NTIS, PC A12/MF A01.

See also PB—87-111720.

Precision and accuracy data obtained from State and local agencies during 1985 are summarized and evaluated. Some comparisons are made with the results reported for prior years to determine any trends. Some trends indicated continued improvement in the completeness of reporting of precision and accuracy data. The national summaries indicate a further improvement in the precision and accuracy assessments of the pollutant-monitoring data collected. The annual results from each reporting organization are given so that comparisons may be made from year to year and also with other reporting organizations.A comparison of the precision and accuracy data from the Precision and Accuracy Reporting System with those from the independent performance audit program conducted by the Environmental Monitoring Systems Laboratory is given.

25809 (PB—87-145660/XAB) Handbook for using foams to control vapors from hazardous spills. Report for April 1984-September 1985. Evans, M.L.; Carroll, H.A. (Science Applications International Corp., McLean, VA (USA)). Jul 1986. 36p. NTIS, PC A03/MF A01.

The handbook describes basic types of foams that may be used to control vapor hazards from spilled volatile chemicals. It provides a table to be used by spill-response personnel to choose an appropriate foam based on the type of chemical spill. Six general types of foams, surfactant (syndet) foams, aqueous film forming foams (AFFF), alcohol type or polar solvent type foams (ATF), and special foams such as Hazmat NF no. 1 which was developed especially for alkaline spills. The handbook provides the basis for spill responders to evaluate and select a foam for vapor control by using the test methods presented or by considering manufacturers specifications for foam-expansion ratios and quarter drainage times. The responder is encouraged to maximize the effectiveness of a foam by trying different nozzles, distances of applications, and thicknesses of the foam layers.

25810 (PB—87-145736/XAB) Gravimetric technique for the preparation of accurate trace organic gas standards. Interim report, January-December 1984. Rhoderick, G.C.; Cuthrell, W.F.; Zielinski, W.L. (National Bureau of Standards, Washington, DC (USA). Gas and Particulate Science Div.). Jan 1987. 12p. NTIS, PC A02/MF A01.

See also report dated 1985, PB—85-207397.

An accurate procedure based on microgravimetry was used for preparation of volatile, hazardous organic chemicals in a nitrogen matrix in pressurized gas cylinders at analyte concentrations ranging from 10 ppb to 10 ppm, by mole. In this technique, the organics of interest are individually weighed into separate glass capillary tubes using a micro-analytical balance. The tubes are sealed, and subsequently broken in a fixed line connected to an evacuated cylinder. A known weight of pre-analyzed matrix gas (nitrogen) is then used to pressurize the cylinder, and the concentrations of the organics are calculated on a molar basis relative to the number of moles of the matrix gas. A number of these gravimetric primary mixtures have been prepared and analytically intercompared using gas chromatography (GC) with flame-ionization detection (FID). Excellent agreement has been found between analyte concentration values prepared gravimetrically and concentration values determined by analysis.

25811 (PB—87-145785/XAB) Characterization of PCB (polychlorinated biphenyl) transformer/capacitor fluids and correlation with PCDDs (polychlorinated dibenzo-p-dioxins) and PCDFs (polychlorinated dibenzofurans) in soot. Campbell, B.; Lee, A. (Technical Resources, Inc., Rockville, MD (USA)). Jan 1987. 125p. NTIS, PC A06/MF A01.

Dielectric fluids in transformers and capacitors often contain polychlorinated biphenyls (PCBs) or chlorobenzenes. These substances may generate polychlorinated dibenzofurans (PCDFs) and polychlorinated dibenzo-p-dioxins (PCDDs) under certain conditions of combustion/pyrolysis. When electrical equipment containing these fluids is involved in an accidental fire, the resulting smoke, soot, and residues may be contaminated with PCDDs, PCDFs, and other toxic chlorinated hydrocarbons. The report contains a review of several laboratory studies investigating the sources of PCDDs and PCDFs as well as the conditions under which they are formed. In addition, some data from sites of actual fire incidents are available and are discussed. Chlorobenzenes and PCBs do not form PCDDs and PCDFs when heated in the absence of oxygen. During fires the dielectric fluid of transformers or capacitors may be leaked or vented from ruptured casings. With exposure to oxygen, PCBs can produce PCDFs and chlorobenzenes can produce PCDDs.

25812 (PB—87-145801/XAB) PM_{10} sampler evaluation program: January 1985 to July 1986. Woods, M.; Chen, F.L.; Ranade, M.B. (Research Triangle Inst., Research Triangle Park, NC (USA)). Jan 1987. 127p. NTIS, PC A07/MF A01.

The report summarizes the activities conducted at the Environmental Monitoring Systems Laboratory's wind tunnel test facility in RTP, NC from January 1985 to July 1986. During this period, the wind-tunnel test procedures proposed for PM_{10} reference and equivalent methods (49 FR 10454) were evaluated and revised. Several shortcomings in the particle sampling and analysis procedures used in the wind-tunnel test facility were identified and eliminated. Specifically, the aerosol distribution system was redesigned, the differences in concentration measurements between an isokinetic high-volume sampler and an array of isokinetic sampling nozzles were investigated, the repeatability of replicate isokinetic sampler measurements was determined, the precision of the analytical technique (fluorometry) was determined, and velocity and turbulence profiles were measured over the range of wind speeds used for testing.

25813 (PB—87-145835/XAB) Pilot-scale incineration test burn of TCDD-contaminated trichlorophenol production waste. Ross, R.W.; Backhouse, T.H.; Vocque, R.H.; Lee, J.W.; Waterland, L.R. (Acurex Corp., Mountain View, CA (USA)). Dec 1986. 88p. NTIS, PC A05/MF A01.

A series of three tests directed at evaluating the incinerability of the toluene stillbottoms waste from trichlorophenol production previously generated by the Vertac Chemical Company were performed in the Combustion Research Facility (CRF) rotary kiln incineration system. This waste contained 37 ppm 2,3,7,8-TCDD as its principal organic hazardous constituent (POHC). Flue gas 2,3,7,8-TCDD levels were less than detectable at all locations sampled. Corresponding incinerator destruction and removal efficiencies (DREs) were greater than 99.9997 percent, based on individual sampling train analyses. By analyzing combined extracts from four simultaneous sampling trains, it was concluded that 2,3,7,8-TCDD DRE was indeed greater than 99.9999 percent. These results suggest that incineration of the Vertac waste is capable of achieving the required DRE and should be considered a treatment option for this waste.

25814 **(PB—87-145843/XAB) User's manual for single-source (CRSTER) model (Addendum).** Catalano, J.A. (Aerocomp, Inc., Costa Mesa, CA (USA)). Jan 1987. 141p. NTIS, PC A07/MF A01.

See also PB—271360.

The Single Source (CRSTER) Model computes hourly concentrations of quasi-stable pollutants in rural or urban settings. The model is applicable to design, modification, and evaluation studies for New Source Review, Prevention of Significant Deterioration, other permit-related applications, and evaluations that require the mathematical simulation of effects from stack effluents of a facility. Up to nineteen collocated stacks can be considered. For various averaging times, impacts are calculated on a polar grid of one hundred eighty receptors which can be at heights other than plant grade provided no receptor exceeds the height of the lowest stack. This addendum gives model changes in conjunction with UNAMAP Version 6. New in this release is the addition of a default option for the automatic setting of variables and program switches for regulatory application of the model.

25815 **(PB—87-145868/XAB) Building a pollutant reservoir aloft by cumulus clouds.** Ching, J.K.S. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Jan 1987. 8p. (EPA—600/D-87/032). NTIS, PC A02/MF A01.

A diagnostic analysis is presented to assess the impact of nonprecipitating clouds on rates of change of pollutant concentration both in the mixed layer and in the free troposphere. This analysis is based on a coupled two-layer (mixed and free tropospheric) conservation of a pollutant-species model, which distinguishes the role of active or venting type clouds from the forced, or fair-weather cumulus clouds. The study examines the sensitivity of the modeled rates of change of pollutant predictions in the mixed layer and in the free troposphere to the method by which the vertical exchange of these venting-class clouds is modeled. This analysis focuses on the vertical redistribution process, the heterogeneous conversion process which are known to be rapid and important is ignored in the study by considering only total pollutant concentration.

25816 **(PB—87-145934/XAB) Laboratory and field evaluation of the Semi-VOST (semi-volatile organic sampling train) method.** Bursey, J.; Steger, J.; Palazzolo, M.; Benson, D.; Homolya, J. (Radian Corp., Research Triangle Park, NC (USA)). Jan 1987. 358p. NTIS, PC A16/MF A01.

See also PB—86-123569.

Laboratory studies and a second field evaluation have been completed to assess the performance of the Semi-Volatile Organic Sampling Train (Semi-VOST) method for measuring concentrations of principal organic hazardous constituents (POHCs) with boiling points greater than 100°C emitted from hazardous-waste incineration. The Semi-VOST methodology was tested initially through a series of laboratory experiments and a field test at a hazardous waste incinerator. In the first field-test method precision and bias were shown to be compound specific. The second field test was performed at a hazardous-waste incinerator using five gaseous deuterated compounds to dynamically spike four simultaneously operating Semi-VOST trains. Toluene, 1,1,2,2-tetrachloroethane, and chlorobenzene were chosen because of boiling point and chemical functionality.

25817 **(PB—87-145942/XAB) Field assessment of aerated lagoon emissions and their control using an inflated dome. Technical report, May 1984-May 1986.** Nelson, T.; Eklund, B.; Wetherold, R. (Radian Corp., Austin, TX (USA)). Jan 1987. 267p. NTIS, PC A12/MF A01.

The fates of volatile organic compounds (VOC) in an industrial-wastewater activated-sludge system were investigated in a 4-day sampling and analysis program. The system included an aerated lagoon which was covered by an inflated synthetic dome and had a carbon adsorption unit to reduce the emissions of odorous organic compounds. Samples of air, water and sludge streams associated with the activated sludge system were collected, along with air samples at the inlet and outlet of the carbon adsorber. These samples were analyzed to determine the concentrations of individual organic constituents. The effectiveness of the dome and carbon adsorption unit in reducing lagoon emissions of volatile organic compounds was investigated, as was the applicability of the Thibodeaux, Parker and Heck model for predicting lagoon emissions. Approximate percentages of removal of VOC by biodegradation, adsorption and volatilization in the aerated lagoon were determined.

25818 **(PB—87-145967/XAB) Wide-area ozone dry-deposition measurements.** Godowitch, J.M.; Ching, J.K.S. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Jan 1987. 6p. (EPA—600/D-87/003). NTIS, PC A02/MF A01.

An experimental study to investigate the temporal and spatial variations of ozone deposition was conducted as part of the Northeast Regional Oxidant Study program in August 1979. Ozone fluctuations and fluxes were obtained from a fast-response ozone sensor on board a research aircraft equipped with gust probes and fast-response temperature probes for turbulence measurements. To obtain aerial measurements of ozone deposition, low-level aircraft runs were performed in the mixed agricultural region around Lancaster, Pennsylvania and in forested terrain to the northwest. Statistical results derived from two case-study days show a maximum ozone-deposition velocity of 0.90 cm/s over the cropland during the early afternoon when convective turbulence was strongest. Ozone flux decreased with height, and it was weaker in a valley compared to a forested ridge due to the presence of a lake along the valley floor. Ozone fluxes were negative during the daytime period in agreement with surface layer tower measurements.

25819 **(PB—87-146247/XAB) Controlled field study to determine the impact of dry and wet deposition of air pollutants on the corrosion rate of galvanized steel.** Edney, E.O.; Stiles, D.C.; Corse, E.W.; Wheeler, M.L.; Spence, J.W. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Jan 1987. 18p. (EPA—600/D-87/018). NTIS, PC A02/MF A01.

Galvanized-steel panels were exposed for 6 months using an automatic covering device at a materials exposure site located at RTP, NC. Galvanized-steel panels were boldly exposed to wet and dry deposition. Another set of panels was mounted on a motor-driven rack that moved the panels under a shelter, thereby preventing rain from falling on them. These panels were sprayed with deionized water during each rain event. IC and AA analysis of the runoff from panels indicated that wet deposition enhances the dissolution rate of Zn surface. Much of the Zn dissolved under both clean rain and dry deposition and total deposition conditions can be accounted for by dry and wet deposition of sulfur species and their reactions of Zn compounds that form on the passive protective film on the galvanized steel panels. This information is essential to the development of a damage model that partitions the effects of wet and dry deposition on galvanized steel.

25820 **(PB—87-146254/XAB) Hybrid receptor models.** Lewis, C.W.; Stevens, R.K. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Jan 1987. 15p. (EPA—600/D-87/019). NTIS, PC A02/MF A01.

A hybrid-receptor model is a specified mathematical procedure that uses not only the ambient-species-concentration measurements that form the input data for a pure-receptor model but, in addition, source emission rates or atmospheric dispersion or transformation information characteristic of dispersion models. By utilizing more information, hybrid-receptor modeling promises improved source-apportionment estimates or, more fundamentally, consideration of problems that are inaccessible in terms of classical receptor modeling. Several examples of hybrid-receptor models are reviewed, emphasizing the great variety in possible approaches, and in the choice of input versus output quantities. A simple illustration is given of a hybrid receptor model applied to the comprehensive ambient-source-meteorological data base collected at Deep Creek Lake, Maryland, during summer 1983.

25821 (PB—87-146353/XAB) Technical, environmental, and economic evaluation of Plastic Media Blasting for paint stripping. Darvin, C.H.; Wilmoth, R.C. (Environmental Protection Agency, Cincinnati, OH (USA). Water Engineering Research Lab.). Jan 1987. 16p. (EPA—600/D-87/028). NTIS, PC A02/MF A01.

The U.S. Army Toxic and Hazardous Materials Agency and the U.S. EPA Water Engineering Research Laboratory cooperated to investigate the feasibility of Plastic Media Blasting (PMB) as a paint-removal technique for aluminum military shelters. The PMB process was compared in field tests with sandblasting and with chemical stripping to determine relative cost, effectiveness, efficiency, and environmental consequence. The PMB process was judged superior to the chemical-stripping process and marginally better than sandblasting based upon the evaluation criteria.

25822 (PB—87-147104/XAB) Some pharmacokinetic and metabolic factors affecting the neonatal toxicity of chlorinated hydrocarbons found in the Great Lakes. Kitchin, K.T.; Kacew, S. (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). Jan 1987. 56p. (EPA—600/D-87/004). NTIS, PC A04/MF A01.

Industrialization has resulted in the emission of a wide variety of organic chemicals into the biosphere. Despite the original source of the organic contaminant, these chemicals have managed to enter drinking-water supplies and bioaccumulate in food chains. Of particular interest are the organic contaminants that have been identified in fish and wildlife in the Great Lakes Basin. As this waterway system functions as an important source of drinking water for North Americans, concern has been raised with respect to toxicity and bioaccumulation of these chemicals. Although a vast number of environmental pollutants have thus far been identified, this chapter will focus on just ten chemicals, principally chlorinated benzenes, octachlorostyrene, and hexachlorobutadiene. The adult, fetal, and neonatal toxicities of these compounds are discussed with emphasis on metabolic and pharmacokinetic factors which influence them.

25823 (PB—87-147153/XAB) Simplified sampling and analysis system for the determination of volatile organic compounds in combustion effluents. James, R.H.; Adams, R.E.; Johnson, L.D. (Southern Research Inst., Birmingham, AL (USA)). Jan 1987. 21p. NTIS, PC A02/MF A01.

The paper gives results of a study to provide a design for a simplified sampling system to support engineering projects for waste combustion requiring numerous semiroutine sampling tests. Sorbents and tandem-bed sorbent sampling tubes were evaluated to develop a rugged, compact collection system for medium-concentration levels of volatile organic compounds (VOCs). Development of the system and laboratory evaluation of the system with selected VOCs are presented. (NOTE: As part of the Resource Conservation and Recovery Act (RCRA), the U.S. EPA has proposed regulations for owners and operators who treat hazardous waste by incineration. To ensure that these incinerators operate in an environmentally responsible manner, the regulations include a requirement that, for selected principal organic hazardous constituents (POHCs), a destruction and removal efficiency (DRE) of equal to or greater than 99.99% must be achieved. The volatile organic sampling train (VOST) was developed and evaluated for sampling very low levels of VOCs in incinerator effluents.)

25824 (PB—87-147179/XAB) Kinetics and selectivity of deep catalytic oxidation of volatile organic compound mixtures. Gangwal, S.K.; Mullins, M.E.; Spivey, J.J.; Caffrey, P.R.; Tichenor, B.A. (Research Triangle Inst., Research Triangle Park, NC (USA)). Jan 1987. 49p. NTIS, PC A03/MF A01.

From Presented at the AIChE meeting; Miami Beach, FL, USA (2-7 Nov 2-7, 1986).

The paper gives results of a fundamental study of low-temperature deep (complete) oxidation of n-hexane, benzene, and ethylacetate over a 0.1% Pt, 3% Ni/gamma-Al$_2$O$_3$ catalyst. (NOTE: Deep catalytic combustion of volatile organic compounds is emerging as an important emission-control technique.) These VOCs were subjected to oxidation as single components and as binary and ternary mixtures at temperatures of 160 to 360 C. n-Hexane oxidation was significantly inhibited in the mixtures, and ethyl acetate oxidation was significantly enhanced in the mixtures. An approach based on the Mars/van Krevlan rate model is being used to explain these inhibitions and enhancements. The model was reasonable successful in predicting the conversion of benzene and n-hexane in their binary mixture, in the intrinsic kinetic region. However, as expected, it overpredicted the conversions in the mass transfer region, since the effect of mass transfer was not incorporated.

25825 (PB—87-147203/XAB) Use of spatial patterns and their uncertainty estimates in the model evaluation process. Dennis, R.L.; Seilkop, S.K. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Jan 1987. 8p. (EPA—600/D-87/031). NTIS, PC A02/MF A01.

Regional model evaluation is a new arena in which traditional residuals analysis has too little to offer. New techniques are needed that address quantification of regional-pattern comparison, accounting for uncertainty, and spatial correlation. Some of the more-promising techniques are discussed. One technique, kriging, reasonably addresses the uncertainty in regional patterns and provides for an objective comparison. Other techniques, while useful, require that the comparison be based on subjective judgments. More work is needed in this area of regional-pattern comparison.

25826 (PB—87-152336/XAB) Ammonia emission factors for the NAPAP (National Acid Precipitation Assessment Program) emission inventory. Final report, January 1985-December 1986. Misenheimer, D.C.; Warn, T.E.; Zelmanowitz, S. (Alliance Technologies Corp., Chapel Hill, NC (USA)). Jan 1987. 63p. NTIS, PC A04/MF A01.

The report provides information on certain sources of ammonia emissions to the atmosphere for use in the National Acid Precipitation Assessment Program (NAPAP) emission inventories. Major anthropogenic sources of ammonia emissions to the atmosphere are identified, and emission factors for these sources are presented based on a review of the most recent data available. The emission factors developed are used to estimate nationwide emissions for base year 1980 and are compared to ammonia emission factors used in other emission inventories. Major anthropogenic source categories covered are cropland spreading of livestock wastes, beef cattle feedlots, fertilizer manufacture and use, fuel combustion, ammonia synthesis, petroleum refineries, and coke manufacture. Approximately 840,000 tons of ammonia is estimated to have been emitted in the U.S. in 1980; over 64% of which is estimated to have been from livestock wastes.

25827 (UCRL—95914) The detection of CO$_2$-induced climate change. MacCracken, M.C.; Grotch, S.L. (Lawrence Livermore National Lab., CA (USA)). Jan 1987. Contract W-7405-ENG-48. 12p. (CONF-8611146—1). NTIS, PC A02. File Number DE87006085.

From Commission of European Communities symposium on CO/sub 2/ and other greenhouse: climate and associated impacts; Brussels, Belgium (3 Nov 1986).

Theoretical projections suggest that the global average temperature will rise and other climatic characteristics will shift as a result of the increasing CO$_2$ and trace gas concentrations. There are important uncertainties, however, regarding the amount and spatial distribution of the changes and the rate at which they will occur.

Improving computer simulations is a possible and necessary step. However, both the identification of the actual changes in the observational record and convincing attribution of them to the increasing CO_2 and trace gas concentrations are essential steps for providing the impetus for what may prove costly adaptative, ameliorative, or preventative steps. The observed rises of global average temperature and of sea level over the past century are suggestive that the 25% increase in CO_2 concentration in this period is, in fact, perturbing the climate. Unexplained discrepancies in magnitude and pattern between theoretical calculations and the observations, however, must be resolved if we are to become able to make the accurate projections needed for determining the appropriate societal responses.

25828 Role of research measurement networks as contributors to federal assessments of acid deposition. Hales, J.M.; Hicks, B.B.; Miller, J.M. (Pacific Northwest Laboratory, Richland, WA 99352). *Bulletin of the American Meteorological Society;* **68**: No. 3, 216-225(Mar 1987).

Three demands for wet-deposition data and dry-deposition data are particularly important at the present time: 1) the analysis of long-term trends to evaluate the consequences of emission changes, 2) the measurement of deposition loadings to determine impacts to receptors, and 3) model development and the analysis of atmospheric source-receptor phenomena. The diversity of these demands has led to deployment of a variety of networks to satisfy different measurement requirements. Consideration of this diversity of network goals has led to a distinction between research-oriented networks and routine measurement networks. Research-oriented networks generally contain a comparatively small number of stations, and make relatively intensive measurements with fine time resolution, to focus on relevant processes. These networks use relatively advanced measurement techniques and require much-greater scientific attention than routine measurement networks. Routine networks usually have a greater number of simpler stations to provide finer spatial resolution, but have a coarser time resolution; they yield a more-descriptive picture of wet and dry deposition over periods of weeks or months. Both types of networks have their place in the overall measurement effort. In this paper, the relationship between existing research arrays and routine-measurement arrays is discussed, and a rationale is suggested for operation of the research arrays—the Multistate Power Production Pollution Study (MAP3S) (for wet deposition) and Core Research Establishment (CORE) (for dry deposition) research measurement networks.

25829 Method of removing oxides of sulfur and oxides of nitrogen from exhaust gases. Walker, R.J. (to Dept. of Energy). US Patent Application 6-795,291. 5 Nov 1985. 17p. DE87007264 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007264.

The invention relates to a method for the simultaneous removal of SO_2 and NO/sub x/ from exhaust or combustion gases.

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REFER ALSO TO CITATION(S) 24827, 25756

25830 (DOE/EV/10374—6) The measurement of ^{222}Rn and its relationship to environmental variables: Factors controlling indoor radon: Final report for the contract period June 1, 1982 to August 31, 1986. Harley, N.H. (New York Univ., NY (USA). School of Medicine). 1986. Contract AC02-80EV10374. 11p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007769.

The report summarizes a project in which a new detector for measuring "radon only" was designed and built. The units built were then used to measure hourly data indoors and outdoors in two locations to investigate the apportionment of the indoor radon source term. (ACR)

25831 (LBL—20210) Understanding the origin of radon indoors: Building a predictive capability. Sextro, R.G. (Lawrence Berkeley Lab., CA (USA)). Dec 1985. Contract AC03-76SF00098. 22p. (CONF-8505195—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87003549.

From EPA conference on characterization of sources of indoor air contaminants; Chapel Hill, NC, USA (12 May 1985).

Indoor radon concentrations one to two orders of magnitude higher than the US average of ~60 Bq m^{-3} (~1.5 pCi L^{-1}) are not uncommon, and concentrations greater than 4000 Bq m^{-3} have been observed in houses in areas with no known artificially-enhanced radon sources. In general, source categories for indoor radon are well known: soil, domestic water, building materials, outdoor air, and natural gas. Soil is thought to be a major source of indoor radon, either through molecular diffusion (usually a minor component) or convective flow of soil gas. While soil gas flow into residences has been demonstrated, no detailed understanding of the important factors affecting the source strength of radon from soil has yet emerged. Preliminary work in this area has identified a number of likely issues, including the concentration of radium in the soil, the emanating fraction, soil type, soil moisture content, and other factors that would influence soil permeability and soil gas transport. Because a significant number of dwellings are expected to have indoor radon concentrations above guideline levels, a predictive capability is needed that would help identify geographical areas having the potential for high indoor concentrations. This paper reviews the preliminary work that has been done to identify important soil and building characteristics that influence the migration of radon and outlines the areas of further research necessary for development of a predictive method. 32 refs., 4 figs.

25832 (LBL—21557) Research review: Indoor air quality control techniques. Fisk, W.J. (Lawrence Berkeley Lab., CA (USA)). Oct 1986. Contract AC03-76SF00098. 37p. (CONF-860446—2). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007603.

From Managing indoor air for health and energy conservation; Atlanta, GA, USA (20 Apr 1986).

Techniques for controlling the concentration of radon, formaldehyde, and combustion products in the indoor air are reviewed. The most effective techniques, which are generally based on limiting or reducing indoor pollutant source strengths, can decrease indoor pollutant concentrations by a factor of 3 to 10. Unless the initial ventilation rate is unusually low, it is difficult to reduce indoor pollutant concentrations more than approximately 50% by increasing the ventilation rate of an entire building. However, the efficiency of indoor pollutant control by ventilation can be enhanced through the use of local exhaust ventilation near concentrated sources of pollutants, by minimizing short circuiting of air from supply to exhaust when pollutant sources are dispersed and, in some situations, by promoting a displacement flow of air and pollutants toward the exhaust. Active air cleaning is also examined briefly. Filtration and electrostatic air cleaning for removal of particles from the indoor air are the most practical and effective currently available techniques of air cleaning. 49 refs., 7 figs.

25833 Early measurements of the Chernobyl fallout in Sweden. Vintersved, I.; De Geer, L.E.; Bjurman, B.; Arntsing, R.; Jakobsson, S.; Mellander, H. (National Defence Research Institute, FOA 215, Nuclear Detection, Box 27322, S-10254 Stockholm). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 590-594(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The accident at the nuclear power plant at Chernobyl resulted in more radioactive fallout over Sweden than over other parts of western Europe. The National Defence Research Institute and the Swedish Geological Company took part in a combined effort to establish the fallout's impact on Sweden. A description on how this was done and what equipment was used is given.

25834 Improved capabilities for area environmental monitoring at Oak Ridge National Laboratory. Morris, A.C. Jr.; Bauer, M.L.; Pudelek, R.E. (Oak Ridge National Lab., Instrumentation and Controls Div., Bldg. 3500, Box X, Oak Ridge, TN 37831-6006). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 595-600(Feb 1987). (CONF-861007—). Contract AC05-84OR21400.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

Recent increased concern for environmental safety hazards resulting from releases of radioactivity and other hazardous materials have necessitated the installation of improved monitoring instruments and methods of Oak Ridge National Laboratory (ORNL). Over the past several years a number of important instrument projects have been initiated to improve plant monitoring systems (both inside the Laboratory and in adjacent East Tennessee areas) and to enhance operational capabilities for detecting releases of hazardous and/or radioactive materials. These measures will significantly modernize and increase the number of monitoring stations measuring activity levels in (1) plant effluent gases, (2) plant effluent liquid wastes, and (3) local streams and rivers. Monitoring instruments within the operating buildings of the Laboratory are being upgraded, and three instrumented meteorological towers are in service to provide information for calculating deposition patterns over surrounding areas. Advanced, on-line central data collection systems supply continuous information for programmable alarm-level circuits, for display at remote terminals throughout ORNL, and for scientific long-term data base purposes. When these improvements are completed in about two years, the number of environmentally derived signals will significantly exceed 750 monitored values.

25835 **A transuranic aerosol measurement system: Preliminary results.** Prevo, C.T.; Kaifer, R.C.; Rueppel, D.W.; Delvasto, R.M.; Biermann, A.H.; Phelps, P.L. (Lawrence Livermore National Lab., P.O. Box 808 (L-386), Livermore, CA 94550). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 601-605(Feb 1987). (CONF-861007—). Contract W-7405-ENG-48.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The authors have completed the design, fabrication, and assembly of a computer-based prototype system for the measurement of transuranic aerosols in the workplace and environment. This system (called WOTAMS for Workplace Transuranic Aerosol Measurement System) incorporates two detectors: (1) an in-line solid-state alpha detector that sends out an alarm the moment a transuranic release occurs, and (2) an in-vacuum detector that increases off-line-analysis sensitivity. The in-line sensitivity of the system is better than 5.0 MPC-h, and the in-vacuum sensitivity exceeds 0.5 MPC-h.

5005 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 26181

5006 Regulations

REFER ALSO TO CITATION(S) 25773, 25812

51 ENVIRONMENTAL SCIENCES, TERRESTRIAL

5101 Basic Studies

REFER ALSO TO CITATION(S) 24530

25836 **(NP—7900579) Habitat suitability index models: Forster's tern (breeding): Gulf and Atlantic Coasts.** Martin, R.P.; Zwank, P.J. (Louisiana Cooperative Fish and Wildlife Research Unit, Baton Rouge (USA)). Feb 1987. 29p. NWRC, US Fish & Wildlife Serv., 1010 Gause Blvd., Slidell, LA 70458. File Number TI87900579.

A review and synthesis of existing information were used to develop a model for evaluating the quality of breeding habitat for Forster's tern (Sterna forsteri). The model is applicable within the nesting range of Forster's terns along the Gulf of Mexico and Atlantic coast. It is scaled to produce an index between 0 (unsuitable habitat) and 1.0 (optimal habitat). Habitat suitability index models are designed for use with the Habitat Evaluation Procedures previously developed by the US Fish and Wildlife Service. Guidelines for model application and techniques for measuring model variables are provided.

25837 **First-year regeneration in upland hardwoods after two levels of residue removal.** Mann, L.K. (Oak Ridge National Lab., TN). *Canadian Journal of Forest Research;* **14**: No. 3, 336-342(1984). Contract W-7405-ENG-26.

The effects of whole-tree removal versus conventional sawlog harvest on 1st-year regeneration in an upland mixed hardwood site were compared, and sprouting dynamics of species and stump size classes were described. Average sprout production for stumps sampled was greater after conventional harvest: stumps produced taller, denser, and more abundant sprouts. Although sample sizes were small, maximum heights of stump sprouts of Quercus prinus L., Quercus velutina Lam., and Acer rubrum L. were greater on the conventionally harvested area, and sprouts of Liriodendron tulipifera L. and Oxydendrum arboreum (L.) DC. averaged taller after residue removal. However, most species produced more seedlings after residue removal. Differences were related to greater site disturbance with whole-tree harvest. Number of sprouts and biomass per stump showed a binomial-shaped distribution in relation to stump diameter across both treatments, with a maximum at about 30 cm. Biomass of grape was least following whole-tree removal, but this may be related to site quality or the small size of the study area. Regression estimates of sprout dry weight as a function of height were used to estimate sprout production. Conservative estimates of total stump sprout biomass, excluding foliage, 1 year after whole-tree removal averaged 433 kg/ha and after conventional harvest averaged 679 kg/ha. 25 references, 2 figures, 5 tables.

5102 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 25777, 25778, 25789, 25855, 25969, 25976, 25977, 25978, 25988

25838 (CONF-8309248—, pp 82-101) **Investigation of the wet and dry deposition of acidic and heavy-metal components.** Georgii, H.-W.; Rohbock, E.; Perseke, C. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

The transfer of reactive atmospheric trace-gases and of aerosols from the atmosphere to the earth surface is carried out by dry and wet deposition. Wet deposition can be recognised as the product of the precipitation-rate and the concentration of trace-substances in precipitation. The regional wet and dry deposition of acidic compounds and of heavy metal-aerosols will be discussed resulting from measurements in a network in the Federal Republic of Germany and compared with available data from other parts of Europe.

25839 **(DOE/ER/60079—T8) Response of tundra ecosystems to elevated atmospheric carbon dioxide: Final report.** Oechel, W.C. (San Diego State Univ., CA (USA). Systems Ecology Research Group). 1986. Contract AC03-82ER60079. 90p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007553.

This report includes: a detailed description of the system which we have developed for providing control of CO_2 and temperature; the effects of this treatment on ecosystem fluxes of CO_2 at ecosystem; the effects of three years CO_2 enrichment on the photosynthetic response of important tundra species; effects of mineral nutrition and CO_2 enrichment on growth, photosynthesis, and biomass partitioning of tundra species; and the effects of CO_2 on soil respiration.

25840 (DOE/ER/60079—T9) The response of arctic ecosystems to elevated carbon dioxide regimes: Progress report, 1 July 1984-30 June 1985. Oechel, W.C. (San Diego State Univ., CA (USA). Systems Ecology Research Group). 1985. Contract AC03-82ER60079. 56p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007741.

Research progress is reported for the following topics: (1) modeling effects of increased CO_2 on arctic tussock tundra; (2) analysis of ecosystem CO_2 flux through non-linear modeling; (3) results of phytotron experiments; and (4) the effects of elevated CO_2 and temperature on net ecosystem flux. (ACR)

25841 (DOE/EV/10253—5) Multi-solute subsurface transport modeling for energy solid wastes: Final report. Kirkner, D.J. (Notre Dame Univ., IN (USA). Dept. of Civil Engineering). Jan 1987. 178p. NTIS, PC A09/MF A01. File Number DE87005182.

This report details progress on a research effort which has been directed toward the development and application of advanced subsurface solute transport models. Leachates from energy wastes represent a potentially large problem and may become a significant transport pathway for objectionable constituents. The proposal of realistic solutions for the handling of these wastes requires a fundamental knowledge of the mechanisms involved. The major objective of the research has been to understand these important mechanisms and to gather this information, in the form of a subsurface hydrogeochemical transport model, for use in predictive, design and investigative purposes. The approach makes use of batch mechanistic and dynamic column experimental methods, and theoretical mathematical analysis. The emphasis of this research has been on the coupling of realistic chemical interactions, involving homogeneous and heterogeneous systems, with existing subsurface solute flow models.

25842 (PB—87-145603/XAB) Remedial response at the Richmond, California hazardous waste site. (Environmental Protection Agency, Cincinnati, OH (USA). Municipal Environmental Research Lab.). 1985. 19p. (EPA—600/J-85/458). NTIS, PC A02/MF A01.

See also PB—85-121721; Published in Waste Management and Research 3, 9-25(1985).

The U.S. Environmental Protection Agency surveyed 395 uncontrolled hazardous-waste sites where some form of remedial action had been planned. A series of reports on 23 sites representative of various remedial-response activities was prepared. This report from this series deals with the installation of a subsurface clay barrier wall and dike around an existing coastal landfill to prevent leachate from entering San Francisco Bay. Costs, equipment used and method of construction are reported in detail.

25843 Sorption of binary mixtures of aromatic nitrogen heterocyclic compounds on subsurface materials. Zachara, J.M.; Ainsworth, C.C.; Cowan, C.E.; Thomas, B.L. (Pacific Northwest Lab., Richland, WA). *Environmental Science and Technology;* 21: No. 4, 397-402(Apr 1987). Contract AC06-76RL01830.

Single and binary solute sorption of pyridine, quinoline, and acridine has been investigated on two low organic carbon subsurface materials with similar properties but different equilibrium pH when saturated with water. Single solute sorption for all compounds is higher in the acidic soil as compared to the basic soil, reflecting stronger sorption of the protonated organic cations. The protonated species exhibit high selectivity for the exchange complex at low aqueous concentration with selectivity increasing with ring number. Binary sorption experiments with quinoline/pyridine and quinoline/acridine demonstrate that competitive sorption occurs between compounds in the acidic subsoil where the protonated compounds species predominate in solution. In contrast, competition is minimal in the basic subsoil when the compounds are neutral. The competition between compounds is consistent with their measured single solute sorption and suggests mass action on a common set of high-affinity surface sites. A simplified model based on ideal absorbed solution theory (IAS) is used to provide simulations of binary solute sorption that are in good qualitative agreement with experimental results. It is suggested that competition between ionized solutes may significantly influence transport of organic mixtures when the groundwater pH is near the pK/sub a/ of the compounds. 31 references, 7 figures, 6 tables.

5103 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 24659, 24664, 25758, 25834

25844 (LA—10942-MS) Natural radioactivity in lignites and lignite ash: Final report. Greiner, N.R.; Wagner, P. (Los Alamos National Lab., NM (USA)). Apr 1987. Contract W-7405-ENG-36. 60p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007720.

Natural radioactivity in a Texas lignite field and in leachates from lignite ash from power plants was measured. The radioactivity concentrations found (4 ppM uranium in the lignite, 16 ppM uranium in the lignite ash, and a few picocuries of natural radionuclides per liter in the leachates) do not differ appreciably from those found previously in similar samples and in natural materials such as soils and ground waters. Additional information on stable elements are reported for both the lignites and the leachates.

5105 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 24466, 25456, 25841, 26181

25845 (DOE/EA—0320) Environmental assessment: Sale of Segment O of the Oak Ridge Reservation to the City of Oak Ridge, Tennessee. (USDOE Oak Ridge Operations Office, TN; Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 34p. (ORNL/M—317). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007687.

This environmental assessment addresses the impacts due to the proposed sale of Segment O of the Oak Ridge Reservation to the City of Oak Ridge for subsequent transfer to Boeing Tennessee, Inc. for industrial development. The assessment focuses on the proposed development of Segment O for the purpose of storage, final assembly and electronics testing of non-nuclear missiles. No significant environmental impacts will result from construction and operation of the facilities proposed for Segment O. Because of the presence of a National Register-eligible historic site and State-listed threatened and endangered plant species on Segment O, the DOE has stipulated in a Memorandum of Agreement with the City that the land will not be transferred to Boeing for development until protection of these sites is ensured. The probability of onsite explosions and/or fires involving hazardous materials is low if Boeing complies with fire codes and handling and storage regulations. Transportation of hazardous materials and missiles between the Interstate 40 off-ramp and the proposed facility would present a risk of 3.6×10^{-5} fatalities per year; therefore, significant offsite impacts would be unlikely.

25846 (EGG—10282-2149) Capture-recapture estimation of San Joaquin kit fox population size on Naval Petroleum Reserve No. 1, Kern County, California. Harris, C.E.; O'Farrell, T.P.; McCue, P.M.; Kato, T.T. (EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations). Jan 1987. Contract AC08-83NV10282. 49p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008052.

San Joaquin kit fox (Vulpes macrotis mutica) population size was estimated semiannually on the US Department of Energy's Naval Petroleum Reserve No. 1, Kern County, California, between December 1980 and August 1986 using capture-recapture data. Estimates were derived using a calendar graph (minimum population size) and appropriate models that allowed for unequal probability of capture. A total of 469 foxes were captured 930 times. There was a significant decline between the peak population estimates (164, minimum population size; 262, closed population model estimate) obtained in winter 1981 and the estimates for winter 1985 (41, minimum population size; 56, closed population model estimate). Population trends for the portion of the study area affected by petroleum development activities did not differ from those observed in undeveloped habitats. Closed population model tests provided evidence of behavioral response and heterogeneity of capture probability in the kit fox. The proportion of animals known to be alive but untrapped each session ranged between 14% and 77% which also indicated variable trap response. Closed population models provided reliable estimates of population size and its variance when the number of individual foxes captured was at least 40 to 50. Use of the Jolly-Seber open population model with this data set was rejected by the goodness-of-fit test because of the small number of marked foxes that were captured each trapping period and the small number of marked foxes from each release that were eventually recaptured.

25847 (ORNL/TM—10050) **Leaching of metals from alkaline wastes by municipal waste leachate.** Francis, C.W.; Maskarinec, M.P. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 35p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007837.

Four alkaline wastes were leached under anoxic conditions with a municipal waste leachate (MWL) to simulate the codisposal of the wastes in a municipal waste landfill. Two of the four wastes were wastewater treatment plant sludges from electroplating processes, and the other two wastes were resource recovery ashes. The electroplating wastewater sludges contained cadmium, and the resource recovery ashes contained lead at levels that were in excess of the present regulatory standards established by the Resource Conservation Recovery Act (RCRA) extraction test (EP).

52 ENVIRONMENTAL SCIENCES, AQUATIC

5201 Basic Studies

REFER ALSO TO CITATION(S) 24737, 26018

25848 (NP—7900580) **Habitat suitability index models: Juvenile English sole.** Toole, C.L.; Barnhart, R.A.; Onuf, C.P. (California Univ., Eureka (USA). Sea Grant Marine Advisory Program; Humboldt State Univ., Arcata, CA (USA). California Cooperative Fishery Research Unit; Fish and Wildlife Service, Slidell, LA (USA). National Wetlands Research Center). Feb 1987. 34p. National Wetlands Research Center, US Fish & Wildlife Service, 1010 Gause Blvd., Slidell, LA 70458. File Number TI87900580.

A review and synthesis of existing information were used to develop a model for evaluating juvenile English sole habitat. The model is scaled to produce an index between 0 (unsuitable habitat) and 1 (optimal habitat) along the Pacific coast of North America from central California to southern British Columbia in estuaries and lagoons. Habitat suitability models are designed for use with the Habitat Evaluation Procedures previously developed by the US Fish and Wildlife Service. Guidelines for model application and techniques for measuring model variables are provided.

25849 (TR-EL—82-4/82-11.46) **Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest): Common littleneck clam.** Shaw, W.N. (Humboldt State Univ., Trinidad, CA (USA). Fred Telonicher Marine Lab.; Fish and Wildlife Service, Slidell, LA (USA). National Wetlands Research Center). Apr 1986. 18p. NTIS, PC A02/MF A01. File Number TI86901603.

Common littleneck clam (Protothaca staminea) supports an important sport fishery in the Pacific Southwest Region, but has no commercial importance. The species is distributed from Alaska to Baja, California. The egg develops into the trochophore stage 12 h after fertilization, and the planktonic larval stage lasts about 3 weeks. Adults usually mature in the second or third year of life. Mortality is greatest early in life. Intraspecific competition among adults is more evident in mud than in sand. Most littleneck clams live in the lower intertidal zone. Littleneck clams concentrate heavy metals and are highly sensitive to copper.

5202 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 24537, 24538, 24779, 25777, 25789, 25821, 25988

25850 (CONF-870502—1) **A regional screening method for classifying pollutant status of coastal waters.** Hunsaker, C.T.; Huq, M.V.; Adams, S.M. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA). Dept. of Ecology). 1987. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006631.

From 5. symposium on coastal and ocean management; Seattle, WA, USA (26 May 1987).

A regional assessment method has been developed to classify estuaries on the basis of their degree of pollution enabling resource managers to prioritize clean-up and future research efforts. The method is based on two key components for each pollutant of interest: an estimate of the pollutant's loading rates into an estuary or region, and information regarding its fate and effects in the environment. Surface water and atmospheric inputs of pollutants are examined. Methods to quantify the uncertainty factors associated with these estimates are suggested. A demonstration of the assessment method focuses on polychlorinated biphenyls as a representative pollutant and on Winyah Bay, South Carolina, as a specific estuarine system. Further research to quantify the effects of environmental processes such as sorption, sedimentation, and volatilization would allow expansion and refinement of the model to permit more accurate estimates of pollutant concentrations.

25851 (CONF-870577—1) **Adirondack lake system acidity: Differences between headwater and nonheadwater lakes.** Hunsaker, C.T.; Olson, R.J.; Carpenter, D.E. (Oak Ridge National Lab., TN (USA); California Univ., Los Angeles (USA)). 1987. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006630.

From International symposium on acidification and water pathways; Bolkesjo, Norway (4 May 1987).

Surface water acidification may be caused or influenced by natural watershed processes and by anthropogenic activities. One portion of the US National Acid Precipitation Assessment Program focused on lake acidity as related to natural and anthropogenic watershed attributes in the Adirondack region of New York. The objectives were to (1) build a series of data sets for complex watershed systems that would complement those developed for headwater lakes and (2) analyze empirical relationships between lake pH and watershed attributes for complex watershed systems, to determine if different processes operate in headwater and nonheadwater watersheds. Sixty-six watershed systems (258 lakes) were studied, using chemistry data available for one-half of these lakes. Results show that headwater lakes had a slightly lower average pH (0.26 units) than nonheadwater lakes. Physical and chemical soil attributes were related to differences in lake acidity between headwater and nonheadwater lakes.

25852 (CONF-8309248—, pp 167-185) **Effects of acid depositions on aquatic ecosystems.** Hultberg, H. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

Acid generating substances affects both by direct deposition to lakes and streams, and indirectly by deposition to the terrestrial ecosystem and export to the aquatic ecosystem. The interaction between catchment response varies with neutralizing capacity, deposited amounts of acid anions, retention and leaching processes, as well as hydrological dynamics. In aquatic systems situated in areas with low acid-neutralizing capacity, pH in lakes and streams have decreased and concentrations of metals have increased. Fish and other aquatic organisms have been affected. Most trophical levels show decrease in species composition, abundance or productivity. Valuable fisheries have been lost over large areas both in Europe and in North America.

25853 (PB—87-145629/XAB) Bromoform formation in ozonated groundwater containing bromide and humic substances. Cooper, W.J.; Amy, G.L.; Moore, C.A.; Zika, R.G. (Florida International Univ., Miami (USA). Drinking Water Research Center). 1986. 17p. NTIS, PC A02/MF A01.

Published in Ozone Science and Engineering, Vol. 8, No. 1, 63-76(Jan 1986).

The effect of bromide ion, organic carbon concentration (natural aquatic humic substances), pH, and solar irradiation on the formation of bromoform in ozonated groundwater has been studied. The studies were conducted on four unique samples of groundwater taken from different regions of the Biscayne Aquifer in southern Florida. All other conditions being equal, increases in bromide ion concentrations resulted in increases in $CHBr_3$ formation. In three of the four samples, $CHBr_3$ formation decreased as the pH level increased from 5 to 9. The fourth sample exhibited an opposite trend whereby the $CHBr_3$ concentration increased with increasing pH. Bromoform concentration increased with increased O_3 concentration over an ozone dosage range of 3.4 to 6.7 mg/L. Ozonated samples placed in sunlight immediately after ozone addition showed a decrease in the formation of $CHBr_3$ presumably due to the photodecomposition of HOBr/OBr.

25854 (PB—87-145769/XAB) Interpreting patterns of lake alkalinity in the Upper Midwest region, USA. Griffith, G.E.; Omernik, J.M.; Kinney, A.J. (Northrop Services, Inc., Corvallis, OR (USA)). Jan 1987. 25p. NTIS, PC A02/MF A01.

To clarify the extent of sensitivity of surface waters to acidic deposition in Minnesota, Wisconsin, and Michigan, lake and stream patterns were mapped for alkalinity. Data were analyzed from approximately 14,000 lakes and streams and evaluated for the apparent spatial associations between these data and macro-scale factors thought to influence alkalinity (such as land use, land forms, hydrology, geology, and soils). The level to which each factor is important in influencing alkalinity varies within the region. The regional map compiled in the study helps meet the urgent need to understand the relative potential sensitivity of surface waters in the Upper Midwest, provides a tool for selecting geographic areas for more detailed studies, and allows more accurate regional assessments of effects of acidic deposition on aquatic resources.

25855 (PB—87-145819/XAB) National surface water survey. National stream survey (Phase 1 - pilot, mid-Atlantic Phase 1, southeast screening, and episodes pilot) quality-assurance plan. Final report. Drouse, S.K.; Hillman, D.C.; Engels, J.L.; Creelman, L.W.; Simon, S.J. (Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV (USA)). Dec 1986. 236p. NTIS, PC A11/MF A01.

The Quality Assurance plan documents the QA/QC and methods used for the National Stream Survey of the Aquatic Effects Research Program (Task Group E) of the National Acid Precipitation Assessment Program. The plan is based on the guidance and specifications provided by the Quality Assurance Management Staff (QAMS, 1980) of the Office of Research and Development. Methods are detailed in a companion document, but this plan gives the internal quality control used by the contract analytical laboratories. Detailed QA/QC procedures are given for all processes from field sampling, through sample processing and analysis, to entry and verification of the data in a data base. The data checks, statistical assessments and component comparisons used in data verification are presented in detail.

25856 (TVA/ONRED/AWR—86/33) Technical report series: North Alabama water quality assessment: Volume 7, Contaminants in biota. Dycus, D.L. (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). Apr 1986. 100p. NTIS, PC A05/MF A01. File Number DE87900603.

This report provides results and recommendations from a two-part study conducted to determine concentrations of various contaminants in biota from Wilson and upper Pickwick Reservoirs in north Alabama. One part of the study was a "screening" effort where fish, clams, and turtles were analyzed as composites for contaminants on the Environmental Protection Agency's list of priority pollutants. The other part was specific to polychlorinated biphenyls (PCBs) because there was a known source of PCBs. Analysis of biological samples for priority pollutants identified few contaminants present in detectable quantities. Of those detected, some were sufficiently low to be of no concern. Presence of cadmium in turtle livers and clam flesh indicates a need for further evaluation because this metal is highly toxic to aquatic life. Phthalate esters in turtles from one location were quite high, but were low in fish and clam samples. Results of PCB analyses indicated largemouth bass and crappie contamination levels were well below the FDSA limit of 2.0 μg/g. Data for buffalo were not as conclusive. Highest PCB concentrations occurred in catfish from Wilson Reservoir. Twenty-two of 45 individuals from Wilson Reservoir exceeded the FDA limit and the overall average was 2.6 μg/g.

25857 (TVA/ONRED/AWR—87/18) Technical report series: Concentrations of PCBs, DDTr, and selected metals in biota from Guntersville Reservoir. Dycus, D.L.; Lowery, D.R. (Tennessee Valley Authority, Chattanooga (USA). Office of Natural Resources and Economic Development). Oct 1986. 77p. NTIS, PC A05/MF A01. File Number DE87900613.

The purpose was to determine if there was potential for human health risks from consumption of reservoir fish or if selected toxic substances might be impacting reservoir biota. Fillets from catfish (channel and blue) and largemouth bass were analyzed for the first purpose and whole gizzard shad, catfish livers, and turtle livers and fat were analyzed for the second. Results indicate largemouth bass should be safe for consumption based on low levels of tested contaminants. However, three of sixteen catfish samples contained PCB levels above the Food and Drug Administration (FDA) tolerance of 2.0 μg/g, and seven others contained levels sufficiently close to that value to warrant concern. DDT and its metabolites and selected metals were low in catfish except for chromium, nickel, and mercury in selected cases. Analyses on all sample types (those referenced above plus catfish livers and turtle fat and livers) indicated levels of metals were generally low and probably not individually impacting reservoir biota.

25858 Anaerobic microbial dissolution of lead and production of organic acids. Francis, A.J.; Dodge, C.; Chendrayan, K. (to Dept. of Energy). US Patent Application 6-834,675. 28 Feb 1986. 12p. Contract AC02-76CH00016. DE87007301 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007301.

The present invention relates to a method of solubilizing lead, in the form of lead oxide, found in industrial wastes, before these wastes are dumped into the environment. The lead is solubilized by dissolving the lead oxide in the wastes through contact with an anaerobic bacterial culture containing the bacterium ATCC No. 53464. The solubilized lead can then be removed from the wastes by chemical separation. It could also be removed by extending the contact period with the bacterial culture. As the culture grows, the solubilized lead is removed from the wastes by bioaccumulation by the microorganism or by immobilization by a polymer-like material produced by the microorganism. At this point, the lead is then removed from the wastes when the waste material is separated from the bacterial culture. If desired, the bacterial culture could be digested at this point to yield relatively pure lead for further industrial use.

25859 Finite element method with region wise iteration scheme for solving groundwater solute transport equation. Yeh, G.T.; Hwang, J.C. (Oak Ridge National Lab., Oak Ridge, TN). pp 161-166 of Second international conference on ground water quality research. Durham, N.N.; Redelfs, A.E. Stillwater, OK; National Center for Ground Water Research (1984). (CONF-8403114—).

From International conference on ground water quality; Tulsa, OK, USA (26 Mar 1984).

By using subregion iteration with the orthogonal weighting finite element method for the computations of large-field problems of ground water soluble transport, the CPU memory requirement can be drastically reduced. The convergence rate is enhanced over the pointwise iteration method. The use of orthogonal weighting functions assures the convergence because the resulting coefficient matrix is always irreducible and diagonally dominant. Such properties of a matrix are closely related to the sufficient conditions for the convergence of an iteration method. Computer runs for test problems were carried out for 10 x 10, 30 x 30 and 50 x 50 grid systems with 2, 3 and 4 subregions. The CPU memory and CPU time were monitored during each run. The numbers of iterations required for the convergence in each time step were also recorded. The results are useful information for the determination of the number of subregion required for a given computer memory capacity and for the estimation of the CPU time using the subregion iteration method.

5203 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 24630, 24666, 25834

5205 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 26002, 26181

25860 (DOE/EA—0310) **Environmental Assessment: Umatilla fish hatchery.** (USDOE Bonneville Power Administration, Portland, OR. Office of Power and Resources Management). Feb 1987. 75p. NTIS MF A01; 2; GPO Dep. File Number DE87007038.

Environmental impacts of the fish hatchery expansion alternative are addressed. It is possible that numbers and species of fish produced could change through a future cooperative ODF & W/CTUIR hatchery master planning process. However, the environmental impacts of an expanded hatchery are expected to be basically the same as described in this document. The master plan includes the following information for the proposed Umatilla Fish Hatchery: rearing schedules and release sites and schedules; a detailed production profile that includes numbers of fish to be released and expected annual adult returns; harvest strategies for naturally and hatchery produced fish; proposed management policies and hatchery practices which will ensure that hatchery releases are coordinated with other fishery management agencies and tribes in the Columbia River Basin; and a proposal for biological monitoring and evaluation of the hatchery program. Development of the Umatilla Fish Hatchery, a joint agency effort, is designed to preserve and enhance summer steelhead and possibly spring and fall chinook salmon stocks of the Umatilla River. The hatchery would provide increased harvest opportunities to the commercial, ceremonial, and subsistence fisheries of the CTUIR and the regional sport fishery.

25861 **(NP—7900574) The ecology of Tijuana Estuary, California: An estuarine profile.** Zedler, J.B.; Nordby, C.S. (San Diego State Univ., CA (USA). Dept. of Biology). Jun 1986. 116p. US Fish and Wildlife Service, 1010 Gause Blvd., Slidell, LA 70458. File Number TI87900574.

This is the first attempt to synthesize and interpret a rapidly growing data base on the estuary's diverse biota - its vegetation, algae, birds, fishes, and invertebrates. Because so many changes have occurred in response to recent catastrophic events, we describe how each aspect of the estuary appeared before 1980 and how it has responded to several perturbations. The experimental tests of these cause-effect relationships have not been completed, and there is little reason to expect that environmental conditions have stabilized or that new types of disturbances won't occur. Thus, this profile should be viewed as a stage in the process of understanding Tijuana Estuary. Like the estuary itself, our knowledge is continuously evolving.

5206 Regulations

REFER ALSO TO CITATION(S) 25860

53 ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

5301 Social And Economic Studies

25862 (CONF-8309248—, pp 278-299) **Overall economic aspects of various abatement strategies and of the processes for reduction of emissions.** Benarie, M. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

The paper contains a few estimates of acid precipitation damages in Europe. Damage to fish stocks in Scandinavia is evaluated at Dollar 58 million annually; material damages for Europe are superior to this figure probably by a factor of ten. The great unknown remains forest damage in Central Europe. For the time being, the absence of a damage function precludes anything but guesses. After a very summary review of the abatement methods, it is shown that the optimization of abatement strategies may progress only on a plant-by-plant basis. The sum of site-specific plans may add up to a national strategy, but it would be an error to specify first a broad strategy and then apply it rigidly on large scale. The cost of fuel desulphurization processes is between 12 and 30% of the (energy) value of feedstock; flue gas desulphurization costs between 8.1 and 17.7% of the price of the KWh.

5302 Assessment Of Energy Technologies

REFER ALSO TO CITATION(S) 25845, 25860

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5502 Biochemistry

REFER ALSO TO CITATION(S) 24699, 25361, 25915, 25991, 25992

25863 **(LBL—22058) Expression of mammalian metallothionein genes in Escherichia coli and in Saccharomyces cerevisiae.** Hou, Ya-Ming. (Lawrence Berkeley Lab., CA (USA)). Aug 1986. Contract AC03-76SF00098. 164p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE87008237.

The metallothionein genes of mouse and human were expressed in Escherichia coli and in Saccharomyces cerevisiae, respectively. The mammalian metallothionein genes code for a group of proteins that are low molecular weight, rich in cysteine and capable of binding heavy metal ions such as cadmium (Cd^{+2}) and zinc (Zn^{+2}). Expression of a metallothionein gene renders bacteria and yeast more resistant to heavy metal ions under a variety of growth conditions. This effect is specific for metallothionein because of gene expression is inactivated, bacteria and yeast become sensitive to metals. In addition, bacteria show a preferential incorporation of Cd^{+2} ions upon gene expression and contain a protein species that is readily labelled by [^{35}S]cysteine. Yeast also contain a protein of a similar molecular weight as the mammalian species but show characteristics that indicate the cells are under stress. Expression of metallothionein has a toxic effect on the microorganism, especially for yeast. The amounts of metallothionein detectable in both bacteria and yeast lysates are low. Several experiments suggest that metallothionein is quickly degraded in the presence of cell lysate. The low level of gene expression and/or the degradation of the gene product make it difficult to detect the expressed metallothionein in the bacterial or yeast lysate. 133 refs., 32 figs., 12 tabs.

25864 Circular differential scattering and circular differential absorption of DNA-protein condensates and of dyes bound to DNA-protein condensates. Phillips, C.L.; Mickols, W.E.; Maestre, M.F.; Tinoco, I. Jr. (Lawrence Berkeley Lab., CA). *Biochemistry;* No. 24, 7803-7811(2 Dec 1986).

DNA-protein condensates that give positive and negative psi-type circular dichroism (CD) spectra (psi condensates) bind intercalative and nonintercalative dyes. CD depends both on circular differential scattering and on circular differential absorption; scattering-corrected CD measurements are approximations to circular differential absorption. The circular differential scattering and scattering-corrected CD patterns observed in the DNA absorption band of psi condensates are mimicked in the induced CD band of intercalators bound to psi condensates. The induced scattering-corrected CD and circular differential scattering patterns of the groove-binding dye Hoechst 33342 bound to psi condensates are the inverse of the patterns seen with intercalative dyes, whereas the groove-binding dye manganese(III) meso-tetrakis(4-N-methylpyridyl)porphine [MnIIITMpyP-4] shows no significant induced CD patterns. The large circular differential scattering and scattering-corrected CD bands are interpreted as resulting from long-range chiral packing, rather than near-neighbor short-range interactions. Dyes intercalated into the DNA of the psi condensates have the same type of long-range chiral packing as the DNA bases. Therefore, the psi-type CD spectra seen in the UV spectra originating from the long-range packing of the DNA bases are also observed in the visible spectra when dyes are intercalated in the DNA of the psi condensates. Our interpretation comes from the observation that the induced circular differential scattering and circular differential absorption of the dye bound to the psi condensates depend only upon the sign of the circular differential absorption and the pattern of the circular differential scattering of the psi condensates without bound dye.

25865 Nucleotide and deduced polypeptide sequences of the photosynthetic reaction-center, B870 antenna, and flanking polypeptides from R. capsulata. Youvan, D.C.; Bylina, E.J.; Alberti, M.; Begusch, H.; Hearst, J.E. (Lawrence Berkeley Lab., CA). *Cell;* **37**: 949-957(Jul 1984). Contract AC03-76SF00098.

The complete nucleotide sequence (8867 bp) and the deduced polypeptide sequence are given for 11 proteins from the photosynthetic gene cluster of R. capsulata (46 kb), including the photosynthetic reaction-center L, M, and H subunits and the B870α and B870β polypeptides (light-harvesting I). These polypeptides bind bacteriochlorophyll, bacteriopheophytin, carotenoids, and quinones that are involved in the primary light reactions of photosynthesis. Hydropathy plots indicate that the L and M subunits are transmembrane proteins that may cross the membrane five times, while the H subunit has only one hydrophobic section near the amino terminus, which may be transmembrane. The L and M subunits are homologous over their entire length and have a high degree of homology with the Q/sub B/ protein from photosystem II of higher plants. An additional six genes were identified that may have some unknown role in bioenergetics since only mutations that affect the differentiation of the photosynthetic apparatus are known to map to this gene cluster. 29 references, 6 figures.

5503 Cytology

REFER ALSO TO CITATION(S) 25961

25866 (UCRL—96245) Current capabilities and clinical applications of image cytometry. Mayall, B.H. (California Univ., San Francisco (USA). Dept. of Lab. Medicine; Lawrence Livermore National Lab., CA (USA)). 1986. Contract W-7405-ENG-48. 15p. (CONF-8609265—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007335.

From Clinical applications of cytometry; Charleston, SC, USA (30 Sep 1986).

The principles of image cytometry are discussed and their application to problems of clinical relevance is illustrated. Image cytometry is based on familiar technology, it now is commercially available and is relatively inexpensive, and it is ready to be applied directly in the clinical laboratory. Image cytometry, when used as an adjunct to conventional pathodiagnosis and clinical evaluation, will provide pathologists and clinicians with a technique of great diagnostic power. It will assist in establishing the prognosis and therapeutic response of patients, particularly those suffering from malignant and premalignant conditions. Routine application of cytometry, both image and flow, will improve the quality and rationale of patient therapy and so will lead to better health care and possibly to lowered morbidity and mortality. 19 refs., 3 figs.

5504 Genetics

REFER ALSO TO CITATION(S) 24699

25867 (DOE/ER/13539—1) Organization of the R chromosome region in maize: Report of progress. Kermicle, J. (Wisconsin Univ., Madison (USA). Lab. of Genetics). Feb 1987. Contract FG02-86ER13539. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007966.

The maize R gene exhibits various features of regulated gene expression. Alleles collected from diverse geographic sources govern the presence and distribution of anthocyanin pigmentation, plant part by plant part. Some alleles confer stable patterns of pigmentation, while others confer unstable somatic phenotypes with frequent germinal mutations. A remarkable change in expression occurs when certain alleles are combined as heterozygotes. Efficient analysis of such phenomena requires a basic understanding of allelic organization. R is organized on a modular basis, with polymorphism both for number and kind of unit. An allele may carry one such unit, or two or more associated with duplicated chromosome segments. When multiple, each unit mutates independently, with its variants constituting a single complementation group. Because such units behave as separate genes, they have been referred to as "genic elements". Alleles organized as gene complexes often have been utilized in the discovery and initial description of phenomena of R regulation. When this is so, subsequent analysis proceeds in two stages. The complex is first fractionated by recombination into simpler derivatives that manifest the phenomenon. Such derivatives, preferably carrying a single element, are then candidates for detailed analysis. For the present study, insertional mutagenesis using transposable sequences proved the most effective means of producing R variants for fine structure study. It was also necessary to describe the pattern of recombination that prevailed in this region when insertions were present. With the advent of molecular cloning of maize genes by transposon tagging, a more direct means of investigating R structure was envisioned. 12 refs.

25868 Genetic-physical mapping of a photosynthetic gene cluster from R. capsulata. Zsebo, K.M.; Hearst, J.E. (Lawrence Berkeley Lab., CA). *Cell;* **37**: 937-947(Jul 1984). Contract AC03-76SF00098.

Transposon mutagenesis and complementation analysis of the photosynthesis genes in Rhodopseudomonas capsulata is presented utilizing Tn5.7 mutagenized R-primes. The R-prime pRPS404 contains many of the genes necessary for the differentiation of the photosynthetic apparatus. Utilizing homologous recombination, 30 independent copies of Tn5.7 were inserted into the R. capsulata chromosome with subsequent deletion of wild-type alleles. Mutants were characterized by absorption spectroscopy, SDS-PAGE, and determination of capability for photosynthetic growth. Many mutations in the bacteriochlorophyll and carotenoid biosynthetic pathways were isolated. A regulator mutation was isolated affecting reaction-center synthesis as well as a 44 kd heme-containing polypeptide. Complementation analysis using various pRPR404::Tn5.7 plasmids has led to the postulation of transcriptional units. 32 references, 7 figures, 2 tables.

25869 Yeast amber suppressors corresponding to $tRNA_3$/ sup Leu/ genes. Liebman, S.W.; Srodulski, Z.; Reed, C.R.; Stewart, J.W.; Sherman, F.; Brennan, G. (Univ. of Illinois, Chicago). *Journal of Molecular Biology;* **178**: 209-226(1984). Contract AC02-76EV03490.

Amber suppressors previously isolated from the yeast Saccharomyces cerevisiae and belonging to the same phenotypic class were assigned to nine different linkage groups named SUP52 through SUP60. One of these suppressors, SUP52, had been shown to cause the insertion of leucine and had been genetically mapped.

The following additional amber suppressors were mapped: SUP53 maps near the centromere of chromosome III closely linked to leu2; SUP54 maps on chromosome VII, 6 cM distal to trp5; SUP56 maps on chromosome I, 5.4 cM distal to ade1; SUP57 maps on chromosome VI, closely linked to met10; and SUP58 maps on the left arm of chromosome XI, loosely linked to met14. The authors show by protein analysis that like SUP52, the suppressors SUP53 through SUP56 are leucine-inserters. Furthermore, by hybridization with a cloned tRNA$_3$/sup Leu/ probe the authors demonstrate that at least SUP53, SUP54, SUP55 and SUP56 contain mutations in redundant tRNA$_3$/sup Leu/ genes because they each generate a new XbaI site in a DNA fragment encompassing a tRNA$_3$/sup Leu/ gene. These new XbaI sites are predicted by the known sequences of tRNA$_3$/sup Leu/ genes if the CAA anticodon mutates to the amber suppressing anticodon CTA. It is likely that each of the nine suppressors in this phenotypic class contain similar mutations in different tRNA$_3$/sup Leu/ genes since the authors find that there are approximately nine unlinked redundant copies of tRNA$_3$/sup Leu/ genes in haploid strains. 50 references, 4 figures, 8 tables.

5505 Metabolism

REFER ALSO TO CITATION(S) 25993

25870 **(BNL—39108) The cellular metabolism of lead and calcium: A kinetic analysis in cultured osteoclastic bone cells.** Rosen, J.F.; Pounds, J.G. (Albert Einstein Coll. of Medicine, Bronx, NY (USA). Dept. of Pediatrics; Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 15p. (CONF-8611123—1). NTIS, PC A02. File Number DE87005388.

From Meeting on bone and renal failure; Antwerp, Belgium (1 Nov 1986).

Characterization of lead metabolism in bone is necessary to understand the role of skeletal lead, an endogenous source of this toxic metal, in the expression of adverse effects of lead intoxication in concert with external sources. Moreover, it has been postulated that an early manifestation of lead toxicity common to diverse cell types may be pertubations in intracellular calcium homeostasis. Furthermore, it has been suggested that calciotropic hormones may express their actions on bone cells by modulating the messenger functions of intracellular Ca. Before these postulates can be more fully tested, the homeostasis of intracellular Pb and Ca must be understood more clearly. We have designed experiments to characterize the steady-state kinetic distribution and behavior of ^{210}Pb and ^{45}Ca in osteoclastic bone cells and to identify biological structures or functions associated with the kinetic pools. Cultures were labeled with ^{210}Pb or ^{45}Ca and the kinetic parameters were obtained by analysis of isotope washout curves. Cellular metabolism was defined by three kinetic pools of intracellular Pb and Ca. The largest and slowest exchanging pool was characterized as a mitochondrial compartment for both metals. These data indicate that Pb and Ca share similar intracellular pathways in osteoclastic bone cells and that both metals are readily exchangeable in this in vitro system. The results of other experiments have revealed that lead, at relatively low medium concentrations, produces a marked increase in all three intracellular Ca compartments. 18 refs., 2 figs.

25871 **(BNL—39428) International symposium on in vivo body composition studies: Program and abstracts.** (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 97p. (CONF-8609203—Absts.). NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87006750.

From International symposium on in-vivo body composition studies; Upton, NY, USA (28 Sep 1986).

This booklet contains the program and individual abstracts for papers presented at the International symposium on in vivo body composition studies. The presentations were divided into five sessions. Individual abstracts were indexed for the Energy Data Base. (DT)

25872 **Steady-state room temperature fluorescence and CO$_2$ assimilation rates in intact leaves.** Sharkey, T.D. (Desert Research Institute, Reno, NV). *Photosynthesis Research;* 7: 163-174(1985). Contract FG08-84ER13234.

Steady-state room temperature variable fluorescence from leaves was measured as a function of CO$_2$ pressure in Xanthium strumarium L. and Phaseolus vulgaris L. Measurements were made in a range of light intensities, at normal and low O$_2$ partial pressure and over a range of temperatures. At low CO$_2$ pressure fluorescence increased with increasing CO$_2$. At higher CO$_2$ pressure fluorescence usually decreased with increasing CO$_2$ but occasionally increased slightly. The transition CO$_2$ pressure between the responses could be changed by changing light, O$_2$ pressure, or temperature. This breakpoint in the fluorescence-CO$_2$ curve was a reliable indicator of the transition between ribulose 1,5-bisphosphate (RuBP) saturated assimilation and RuBP regeneration limited assimilation. The fluorescence signal was not a reliable indicator of O$_2$-insensitive assimilation in these C$_3$ species. 21 references, 8 figures.

25873 **Effect of spatial non-uniformity of illumination in non-linear intensity-dependent photophysical experiments. Application to some fluorescence yield measurements in photosynthetic systems.** Paillotin, G.; Geacintov, N.E.; Breton, J. (Centre d-Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). *Photochemistry and Photobiology;* **37**: No. 4, 475-478(1983).

The spatial non-uniformity of a light beam must be taken into account in interpreting phenomena which depend on the light intensity in a non-linear manner. Omission of this effect may lead to incorrect values of parameters obtained from a fitting of theoretical curves, which describe the dependence of a given phenomenon on light intensity, to the experimental data. The effect of spatial non-uniformity of excitation light beams is illustrated utilizing non-linear intensity-dependent fluorescence phenomena in photosynthetic systems and a Gaussian light beam profile. 3 figures, 7 figures.

5506 Medicine

REFER ALSO TO CITATION(S) 25466, 25574, 25925, 25926, 25928, 25929, 25930, 25933, 25937, 26210

25874 **(BNL—38482) Stannous glucoheptonate: An effective tinning agent for Tc-99m labeling of blood cells.** Straub, R.F.; Meinken, G.E.; Srivastava, S.C. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 13p. (CONF-860627—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008204.

From 33. annual meeting of the Society of Nuclear Medicine; Washington, DC, USA (22 Jun 1986).

Of the various tin compounds studied, stannous glucoheptonate proved to be the most effective tinning agent for labelling blood cells with technetium 99. Much less tin was needed to achieve a rapid and satisfactory intracellular Sn(II) content. Less Sn(II) remained extracellular, facilitating its removal by oxidation or washing. Highest /sup 99m/Tc-labeling efficiencies are obtained for RBC, leukocytes, and platelets. Label stability in vitro was higher (2 to 3% washout from /sup 99m/Tc-RBC, and ~ 10% from /sup 99m/Tc-leukocytes and platelets, upon prolonged incubation with saline or plasma). The order of effectiveness for the tinning agents tested is glucoheptonate > citrate >> DTPA > PYP. 4 refs., 6 figs.

25875 **(CONF-851113—, pp 26-36) Microdosimetry of monoclonal antibodies labeled with alpha emitters.** Fisher, D.R. (Battelle, Pacific Northwest Labs., Richland, WA). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The recent discovery of new techniques for the production of monoclonal antibodies (MoAB) has opened up a number of potential new applications in cancer diagnosis and therapy. Monoclonal antibodies labeled with alpha-emitting radionuclides promise to be particularly effective therapeutic agents due to the efficient cell killing ability of highly ionizing, short-range alpha particle tracks localized at specific antigen sites within the tumor mass. For a radioimmunotherapy treatment plan to be effective, one must be able to estimate the absorbed radiation dose to both tumor cells and normal tissues in the body. However, conventional methods used in nuclear medicine for estimating absorbed doses and specific absorbed fractions for radiopharmaceuticals do not apply to alpha emitters owing to their short range and the large variations in the local distribution of energy at the cellular level that result. Microdosimetric techniques developed for assessment of the radiological effects of internally deposited transuranic radionuclides take into account the statistical aspects of alpha particle track structure, energy distribution patterns, and radionuclide distribution within tissues, and provide a means for determining the number and frequency of cells irradiated, the probability densities in specific energy, and the average dose delivered to cells of interest. These techniques can be applied to the study of radiation absorbed dose from alpha-labeled monoclonal antibodies. 16 references, 6 figures.

25876 (CONF-851113—, pp 67-81) **Traversal of cells by radiation and absorbed fraction estimates for electrons and alpha particles.** Eckerman, K.F.; Ryman, J.C.; Taner, A.C.; Kerr, G.D. (Oak Ridge National Lab., TN). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Consideration of the pathlength which radiation traverses in a cell is central to algorithms for estimating energy deposition on a cellular level. Distinct pathlength distributions occur for radionuclides: (1) uniformly distributed in space about the cell (referred to as μ-randomness); (2) uniformly distributed on the surface of the cell (S-randomness); and (3) uniformly distributed within the cell volume (I-randomness). For a spherical cell of diameter d, the mean pathlengths are 2/3d, and 3/4d, respectively, for these distributions. Algorithms for simulating the path of radiation through a cell are presented and the absorbed fraction in the cell and its nucleus are tabulated for low energy electrons and alpha particles emitted on the surface of spherical cells. The algorithms and absorbed fraction data should be of interest to those concerned with the dosimetry of radionuclide-labeled monoclonal antibodies. 8 references, 3 figures, 2 tables.

25877 (CONF-851113—, pp 82-96) **SPECT quantification of regional radionuclide distributions.** Jaszczak, R.J.; Greer, K.L.; Coleman, R.E. (Duke Univ Medical Center, Durham, NC). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

SPECT quantification of regional radionuclide activities within the human body is affected by several physical and instrumental factors including attenuation of photons within the patient, Compton scattered events, the system's finite spatial resolution and object size, finite number of detected events, partial volume effects, the radiopharmaceutical biokinetics, and patient and/or organ motion. Furthermore, other instrumentation factors such as calibration of the center-of-rotation, sampling, and detector nonuniformities will affect the SPECT measurement process. These factors are described, together with examples of compensation methods that are currently available for improving SPECT quantification. SPECT offers the potential to improve in vivo estimates of absorbed dose, provided the acquisition, reconstruction, and compensation procedures are adequately implemented and utilized. 53 references, 2 figures.

25878 (CONF-851113—, pp 97-104) **Quantitation of radiopharmaceutical distribution for use in dose estimates with positron emission tomography.** Hoffman, E.J. (Univ. of California, Los Angeles). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Current PET systems provide a means of obtaining quantitative radiopharmaceutical distributions, which can be accurate for tissue volumes on the order of 1 cc. Properly calibrated PET systems can non-invasively measure amounts of positron emitter in all parts of the body, allowing dose estimations from data obtained with human subjects rather than performing estimates from activity distributions from test animals. Since these are usually rodents, species differences can be large enough to make this type of estimation irrelevant. Before testing in man, it can also be cost effective to measure activity distributions in non-human primates with PET since it would unnecessary to kill animals to obtain data. Typical measurements for developing dosimetry for new positron-emitting radiopharmaceuticals would start with a series of rectilinear scans with the PET system as a function of time, initially on non-human primates. If organs are clearly delineated in rectilinear scans of non-human primates, estimates of human doses can probably be made from that data. Because of species differences and small size of organs, tomographic scanning may not provide significant additional information. Studies could then proceed in man. As above, rectilinear scans as a function of time would define cross-sections to be defined by tomography. Details of studies would be dependent upon sophistication of dosimetry calculations. If calculations assume uniform whole organ distribution, rectilinear scans should provide adequate isotope concentrations and effective half-lives. If more detailed calculations are to be attempted, distributions can be localized to volumes on the order of 1 cc with tomography. 11 references, 6 figures.

25879 (CONF-851113—, pp 105-117) **Maximizing precision and accuracy in quantitative autoradiographic determination of radiopharmaceutical distribution for dosimetry calculation.** Lear, J.L.; Mido, K.; Plotnick, J.; Muth, R. (VA Medical Center, Palo Alto, CA). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The authors developed operational equations which relate ranges of film darkening or optical density produced by exposures from autoradiograms to the ranges of radiopharmaceutical concentration contained in the autoradiograms. The equations were solved and used to define ranges of optical density which were optimal for precise determination of radiopharmaceutical concentration. The solutions indicated that in order to maximize precision in determination of tracer concentration, autoradiograms should be produced with images that are less dark than are typically considered pleasing to the eye. Based upon these observations, a solid state image analyzer was designed and developed for high spatial resolution, quantitative analysis of autoradiograms. The analyzer uses a linear array of charge-coupled devices (CCD's) which mechanically scans the autoradiograms. The images are digitalized into 512 x 512 or 1024 x 1024 pixels with 256 gray levels and directly mapped into memory. The system is therefore called a memory mapped, charge-coupled device scanner (MM-CCD). The images can be directly converted to represent tracer concentration or functional parameters and rapid region of interest analysis can be performed in single or multiple tracer studies. The performance of the system was compared to that of other commercially available image analyzers, rotating drum densitometers and video camera digitizers. Values of tracer concentration using the MM-CCD scanner were generally greater than twice as precise and accurate as from the other systems. 3 references, 4 figures, 3 tables.

25880 (CONF-851113—, pp 118-134) **Acquisition of biokinetic data for internal dose calculations for some novel radiopharmaceuticals.** Smith, T.; Zanelli, G.D.; Crawley, C.W. (MRC Clinical Research Centre, Harrow, England). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Estimation of radiation dose commitment, expresses as an effective dose equivalent, is a prior requisite to the application for a license to administer radiopharmaceuticals and, therefore, in the case of novel radiopharmaceuticals is leading to an increasing awareness of the need for dosimetry-orientated studies. In this laboratory potential new radiopharmaceuticals are investigated initially by animal studies to assess the possible distribution in man, and subsequently in controlled volunteer studies designed to obtain the maximum possible amount of biokinetic data to allow accurate estimation of radiation dose. A variety of techniques are used for this purpose, including profile counting, partial and whole-body scanning by LFOV gamma camera and whole-body counting, in addition to the analysis of radioactivity in blood and excreta. The use of these techniques is illustrated for the acquisition of biokinetic data and subsequent dosimetry of three novel radiopharmaceuticals: ^{77}Br-p-bromospiperone (quantification of dopamine receptors in the brain). ^{99}Tc/sup m/-porphyrins and ^{99}Tc/sup m/ DEPE (a possible novel blood pool marker for MUGA studies). 14 references, 14 figures, 2 tables.

25881 (CONF-851113—, pp 148-154) **Considerations regarding dosimetry in children.** Gilday, D.L. (Univ. of Toronto, Ontario). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The most important consideration when deciding whether or not to perform a nuclear medicine procedure in a child is whether the benefit of the information obtained exceeds the potential risk. In most circumstances the potential benefits are well define. No patient should be studied unless the question to be answered is clearly understood and there is a reasonable change to answer it. To properly perform procedures in children one must not only have a schedule to scale the radiopharmaceutical dose to be administered to the child's body surface area but also one must have an established minimum dose for small babies and infants. There is no point in under-dosing the patient as then the information will not be obtained from the nuclear medicine society. The value of nuclear medicine in the pediatric population cannot be underestimated. It is often the single most important test that can be performed diagnostically. For these reasons it is very important to understand the proper relationship of an adequate study versus the minimization of radiation. 3 references.

25882 (CONF-851113—, pp 267-273) **FDA's requirements for radiation dosimetry of radiopharmaceutical drug products.** Abel, N.M. (Food and Drug Administration, Rockville, MD). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The primary concern of the Office of Drug Research and Review of the Food and Drug Administration in the field of radiation dosimetry is to ensure that radiopharmaceutical drug products are safe when used as investigational drugs (INDs) and are both safe and effective when a new drug application (NDA) is approved. In order to accomplish this, the sponsor of either an IND or applicant in the case of NDA must provide information that clearly describes the radiation dose that a patient will receive from the administration of the drug. The submitted numerical estimates of the radiation dose should be based on an absorbed fraction method of radiation dose calculation, such as the system set forth by the Medical Internal Radiation Dose (MIRD) Committee of the Society of Nuclear Medicine or the system set forth by the International Commission on Radiological Protection (ICRP). This presentation will describe in detail the data that a sponsor of an IND needs to submit to satisfy the regulatory requirements. Examples will be given of common mistakes and omissions by sponsors in their presentation of data.

25883 (CONF-851113—, pp 274-290) **Dosimetry considerations in patients with renal pathology.** Marcus, C.S.; Koyle, M.A. (Harbor-UCLA Medical Center, Torrance). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Adult dosimetry is generally performed for normal individuals and these are the absorbed dose calculations sent to FDA and listed on package inserts. However, in a variety of circumstances pathophysiologic state may significantly alter the biodistribution and kinetics of a radiopharmaceutical, and radiation doses calculated for normal individuals may not be appropriate approximations for these patients. In addition, the presence of certain pathophysiologic states often guarantees that the patient will have multiple studies over a period of days, weeks, months, or years. In order to have a true appreciation for the radiation dose commitment to such patients, it is important to examine dose totals from multiple nuclear medicine studies. Dosimetry calculations will be presented for I-123, I-124, I-125, and I-131 labeled hippuran in moderate and severe ATN, acute and chronic near-total obstruction, and renal transplants. In addition, a nuclear medicine examination profile will be presented for patients receiving renal transplants. This profile was constructed by retrospectively examining the records of 20 randomly-chosen transplant patients and recording all nuclear medicine procedures performed up to July, 1985. A total of 172 studies was performed, of which 69 were Tc-99m-DTPA flows, 62 were hippurans, and 22 were indium-111-oxine-platelets. The dosimetric contribution of all studies was assessed. The importance of the hippuran component will be discussed. 8 references, 8 tables.

25884 (CONF-851113—, pp 319-330) **Kinetic model for the dosimetry of radiopharmaceuticals contaminated by Mo-99.** Shearer, D.R.; Pezzullo, J.C. (Rhode Island Hospital, Providence). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Radiopharmaceuticals tagged with Tc-99m may become contaminated with breakthrough products from the Mo-99/Tc-99m generator. If a fraction of the contaminant becomes bound to the radiopharmaceutical, the dose to the radiopharmaceutical target organ from the contaminant must be considered. The dose to the contaminant target organ may then be calculated as the sum of the doses from a) the initially unbound contaminant, and b) the contaminant later released by degradation of the radiopharmaceutical. This paper presents a model which takes the above processes into account. The model is illustrated with clinical data derived from Mo-99 contaminated radiopharmaceuticals. 5 references, 2 figures, 6 tables.

25885 (CONF-851113—, pp 331-345) **Influence of radioactive contaminants on absorbed dose estimates for radiopharmaceuticals.** Watson, E.E.; Stabin, M.G. Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Several popular radiopharmaceutical products contain low levels of radioactive contaminants. These contaminants increase the radiation absorbed dose to the patient without any increased benefit and, in some cases, with a decrease in image quality. The importance of a contaminant to the radiation dosimetry picture is a function of 1) the contaminant level, 2) the physical half-life of the contaminant, 3) the organ uptake and the biological half-time of the contaminant in the various body systems, and 4) the decay mode, energy, etc. of the contaminant. The general influence of these parameters is discussed in this paper; families of curves are included that reflect the changing importance of contaminant dosimetry with respect to the primary radionuclide as a function of these variables. Several specific examples are also given of currently used radiopharmaceutical products which can contain radioactive contaminants (I-123, In-111, Tl-201, Ir-191m, Rb-82, Au-195m). 7 references, 8 figures, 4 tables.

25886 (CONF-851113—, pp 359-370) **Human absorbed dose calculations for ^{123}I labeled phenyl pentadecanoic acid.** Kulkarni, P.V.; Clark, G.; Corbett, J.R.; Willerson, J.T.; Parkey, R.W. (Univ. of Texas Health Science Center, Dallas). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

I-123 labeled fatty acids have been proposed for studying myocardial metabolism by scintigraphic methods. With the availability of clean I-123 and the advent of single photon emission tomography, I-123 labeled fatty acids would be well suited to study regional myocardial viability or metabolism in humans. The authors have studied I-125 and I-123 labeled iodophenyl pentadecanoic acid (IPPA) in rats and dogs. Clinical studies are in progress with I-123 (IPPA). They have studied the pharmacokinetics of this tracer in male Sprague-Dawley rats at 0.25, 0.5, 1, 3, 6, and 24 hours postinjection. The cumulated doses, due to both pure I-123 and a version contaminated with 1.4% I-125, in various organs and the total body in humans are estimated. The average dose to organs for humans injected with I-123 IPPA with pure I-123 and contaminated I-123 respectively, are (rads to organ per mCi injected): heart wall (0.0507, 0.0514), liver (0.0792, 0.0875), kidneys (0.0479, 0.0561), thyroid (0.0517, 0.0638), ovaries (0.0427, 0.0561), testes (0.0307, 0.0309), total body (0.0386, 0.0392). 12 references, 9 figures, 5 tables.

25887 (CONF-851113—, pp 371-388) **Comparison of radiation dosimetry for several potential myocardial imaging agents.** Watson, E.E.; Stabin, M.G; Goodman, M.M.; Knapp, F.F. Jr.; Srivastava, P.C. Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Although myocardial imaging is currently dominated by Tl-201, several alternative agents with improved physiologic or radionuclidic properties have been proposed. Based on human and animal studies in the literature, the metabolism of several of these compounds was studied for the purpose of generating radiation dose estimates. Dose estimates are listed for several I-123-labeled free fatty acids, an I-123-labeled phosphonium compound, Rb-82, Cu-64, F-18 FDG (all compounds which are taken up by the normal myocardium), and for Tc-99m pyrophosphate (PYP) (which localizes in myocardial infarcts). Dose estimates could not be generated for C-11 palmitate, but his compound was included in a comparison of myocardial retention times. For the I-123-labeled compounds, I-124 was included as a contaminant in generating the dose estimates. Radiation doses were lowest for Rb-82 (gonads 0.3-0.4 Gy/MBq, kidneys 8.6 Gy/MBq). Doses for the I-123-labeled fatty acids were similar to one another, with IPPA being the lowest (gonads 15 Gy/MBq, heart wall 18 Gy/MBq). Doses for Tc-99m PYP were also low (gonads 4-7 Gy/MBq, heart wall 4 Gy/MBq, skeleton 15 Gy/MBq). The desirability of these compounds is discussed briefly, considering half-life, imaging mode and energy, and dosimetry, including a comparison of the effective whole body dose equivalents. 37 references, 11 tables.

25888 (CONF-851113—, pp 409-420) **Dosimetry of radiolabeled monoclonal antibodies used for therapy.** Myers, M.J.; Hooker, G.R.; Epenetos, A.A. (Hammersmith Hospital, London, England). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The present state of radiotherapy using labeled antibodies is reviewed. From the point of view of dosimetry, antibody therapy does not seem to have reached a stable and practicable enough state to provide an input to any but rather tentative dosimetry models. These, therefore, should not be taken too far until the problems of antibody targeting have been more fully developed. Some of the instrumental techniques for acquiring dosimetric data under clinical conditions are discussed as are some of the techniques of therapy in use today. 8 references, 3 figures.

25889 (CONF-851113—, pp 421-445) **Compartmental modeling approach to the radiation dosimetry of radiolabeled antibody.** Zanzonico, P.B.; Bigler, R.E.; Primus, F.J.; Alger, E.; DeJager, R.; Stowe, S.; Ford, E.; Brennan, K. Goldenberg, D.M. (Cornell Medical Center, New York, NY). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Essential for the calculation of absorbed doses from systemically administered radiolabled antibody is the determination of the total number of nuclear transformations in specified source regions. Compartmental analysis (using biodistribution data augmented with a priori physiological information), unlike simply integrating empirical time-activity curves, may enable one to calculate the cumulated activity in unsampled as well as sampled source regions. These may include microscopic source regions (e.g. the intracellular space, cell surface, and extracellular space) important for microdosimetry calculations. Of particular importance is the interaction between the anti-tumor antibody and the tumor antigen. 30 references, 9 figures, 2 tables.

25890 (CONF-851113—, pp 446-457) **Dosimetric measurements and radiobiological consequences of radioimmunotherapy in tumor bearing mice.** Wessels, B.W.; Griffith, M.H.; Bradley, E.W.; Skibinski, B. (George Washington Univ. Medical Center, Washington, DC). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

With the development of the hybridoma technology, the production of highly specific tumor associated monoclonal antibodies has provided new optimism for the adjuvant delivery of therapeutic radiation doses via radioimmunotherapy. The authors have used a modified form of the well-established TL dosimetry technology to measure the dose resulting from radioimmunotherapy experiments in tumor bearing mice. Their laboratory has designed and tested a miniature $CaSO_4$:D TLD which fits conveniently inside a 20 gauge needle for the direct implantation of the dosimeter in an animal model undergoing radiolabeled antibody therapy. Direct measurement of absorbed dose from beta and gamma radiation in the animals may be obtained upon removal of the dosimeter at animal sacrifice or by surgery. This absorbed dose data may then be related to antibody affinity and localization data obtained by serial biodistribution studies. Using p96.5 melanoma antibody with a Brown Tumor Model in athymic mice, localization indices measured in the range of 2 to 4 and scored 4 to 7 days post antibody injection, yielded a tumor dose/whole body dose ratio of 1.10 +/- 0.04 (no enhancement). The dose to liver showed marker time-dependent enhancement relative to the whole body, however. An outline of suggested control radiobiological experiments to be performed in conjunction with radioimmunotherapy experiments has been included in order to provide comparative dose response data. 11 references, 14 figures, 3 tables.

25891 (CONF-851113—, pp 458-463) **Dosimetric considerations in radioimmunotherapy of patients with hepatoma.** Leichner, P.K.; Klein, J.L.; Order, S.E. (Johns Hopkins Oncology Center, Baltimore, MD). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Dosimetric studies of I-131 labeled antiferritin have provided the foundation for preparative and administrative aspects of radiolabeled antibody treatment of patients with hepatoma. Tumor response to I-131 labeled antiferritin IgG was encouraging and radioimmunotherapy with Y-90 labeled antiferritin IgG was recently initiated. For these patients, In-111 labeled antiferritin IgG was used as the imaging agent, with administered activities ranging from 0.8 - 7 mCi. Serial gamma camera imaging from 30 minutes to 6 days post injection demonstrated that 5-30% of the administered activity localized in hepatomas (8/12 patients). The mean value of the effective half-life in the tumor and liver was 2.8 d. Disappearance curves for the blood circulation, spleen, and other normal tissues were biphasic such that 50% of the activity disappeared within 24 hours post injection. The eight patients who demonstrated sufficient tumor localization where subsequently treated with Y-90 labeled antiferritin IgG. Administered activities were dependent on tumor volume and uptake of radiolabeled IgG and ranged from 8 - 20 mCi. The remaining patients were treated under other existing protocols. 10 references.

25892 (CONF-851113—, pp 464-476) **Distribution and dosimetry of indium-111 labeled F(ab')$_2$ fragments in humans.** Doherty, P.; Schwinger, R.; King, M.; Gionet, M. (Univ. of Massachusetts Medical Center, Worcester). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The purpose of this study was to obtain quantitative biodistribution data in patients injected with the indium-111 labeled F(ab')$_2$ fragments of mouse monoclonal antibody. From this data dosimetric calculations were made for the individual organs. The authors also evaluated the quantitative properties of SPECT in this application and compared it with the more conventional two view planar technique in both phantom and patient studies. For one antibody (19-9) the mean dose in rads/mCi for the organs of highest accumulation, namely, the liver and kidneys was 3.2 and 2.6 respectively. Preliminary data from another antibody (OC 125) showed much higher blood levels and a significantly lower liver dose of 2.3 indicating that antibody type is another significant determinant in dosimetry. The SPECT approach particularly in the presence of background activity, was more accurate in the phantom studies and resulted in larger estimated doses in the patient studies. Also, SPECT has the added advantage of providing an index of organ volume, which has to be balanced with the fact the planar is more rapid, and does not require special hardware. 24 references, 5 figures, 1 table.

25893 (CONF-851113—, pp 477-492) **Chelate chase of radiopharmaceuticals reversibly bound to monoclonal antibodies improves dosimetry.** Goodwin, D.A.; Smith, S.I.; Meares, C.F.; David, G.S.; McTigue, M.; Finston, R.A. (Veterans Administration Medical Center, Palo Alto, CA). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

One hundred micrograms of monoclonal antibody (MoAb) CHA 255 with a binding constant Kb of 4 x 10^9 was complexed with indium-111 labeled BLEDTA II, GLEDTA IV, benzyl EDTA, and an EDTA conjugate of Fab. The 24-hour tumor and organ distribution in BALB/c mice bearing KHJJ tumors was studied for each compound alone, the antibody complex, and 3 hours following a chelate chase of the antibody complex. Whole-body biological half-life was measured for 7 days with and without a chelate chase for each antibody complex. The 24-hour whole-body counts dropped 20-60% within 3 hours of administering the chelate chase. Blood concentration fell over 89% within 3 hours of administering the chase and there was a decrease in concentration in all organs, except the kidneys, of 10 to 85%. Theoretical equivalent human doses were calculated from the 24-hour organ concentrations, effective half-life, and MIRD 11 S values (absorbed dose per cumulated activity). Liver and spleen were the target organs, with the dose ranging from 0.50 to 3.91 rads per millicurie. The reduction in organ radiation dose varied up to 95% following the chelate chase. Rapid selective renal clearance of chelate labeled radiopharmaceuticals by competitive inhibition (chelate chase) of their reversible binding to monoclonal antibodies, greatly improves the radiation dosimetry of tumor imaging agents. 28 references, 5 figures, 5 tables.

25894 (CONF-851113—, pp 493-513) **Cis-Platinum-193m: its microdosimetry and potential for chemo-Auger combination therapy of cancer.** Howell, R.W.; Sastry, K.S.R.; Hill, H.Z.; Rao, D.V. (Univ. of Massachusetts, Amherst). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Cis-Platinum is widely used in chemotherapy of cancer. Its usefulness is limited by its chemotoxic effects. The action of this drug involves its binding to DNA base sequences. The overwhelming evidence for the cytocidal effects of DNA-incorporated ^{125}I through localized irradiation of intranuclear radiosensitive sites by the numerous low energy Auger electrons from its decay suggests the interesting prospect of chemo-Auger combination therapy using cis-Pt labeled with suitable radionuclides. In this approach, the localized action of Auger electrons augments the chemical action of cis-Pt for cell killing. Accordingly, possibilities exist for a reduction of the chemotoxicity of the drug. The radionuclides /sup 195m/Pt and /sup 193m/Pt are natural candidates in this regard since both are prolific emitters of low energy Auger electrons by virtue of their decay modes. Preliminary studies with cis-/sup 195m/Pt on experimental mouse tumor models are encouraging. The problem with /sup 195m/Pt is its low specific activity. In contrast, /sup 193m/Pt can be produced at a much higher specific activity, even carrier-free, compared to /sup 195m/Pt. Monte Carlo calculations show that about 25 Auger electrons are to be expected per decay of /sup 193m/Pt. The microdosimetry of these electrons indicates that the localized absorbed energy density around the decay site is more than in the case of ^{125}I. These considerations point to the promise of cis-/sup 193m/Pt fr chemo-Auger combination therapy. The cellular dosimetry of /sup 193m/Pt, localized on the surfaces of cells, is also discussed in the context of the current interest in radioimmunotherapy. 4 references, 4 figures, 6 tables.

25895 (CONF-851113—, pp 514-534) **Aspects of the dosimetry of radionuclides within the skeleton with particular emphasis on the active marrow.** Eckerman, K.F. (Oak Ridge National Lab., TN). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Epidemiological surveys on man and results from animal experiments have shown that two tissues associated with the skeleton are of primary concern with respect to cancer induction by ionizing radiation. These are the cells on or near endosteal surfaces of bone, from which osteosarcomas are thought to arise, and hematopoietic bone marrow, which is associated with leukemia. The complex geometry of the soft tissue-bone intermixture makes calculations of absorbed dose to these target regions a difficult problem. In the case of photon or neutron radiations, charged particle equilibrium may not exist in the vicinity of soft tissue-bone mineral interface. In this paper a general study of the dosimetry of radionuclides within the skeleton is presented. Dosimetric data consistent with the MIRD schema and reflecting the physical and anatomical parameters defining the energy deposition are tabulated for the relevant target regions. 27 references, 5 figures, 5 tables.

25896 (CONF-851113—, pp 535-544) **Bone marrow dosimetry for monoclonal antibody therapy.** Bigler, R.E.; Zanzonico, P.B.; Leonard, R.; Cosma, M.; Primus, F.J.; Alger, E.; DeJager, R.; Stowe, S.; Ford, E.; Brennan, K.; Goldenberg, D.M. (New York Hospital-Cornell Medical Center, NY). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Immunoglobulins must permeate through the basement membrane of capillaries in order to enter the extracellular space (ECS) of tissue. Since the process is quite slow, the blood plasma activity in various organs contributes considerably to the radiation dose of the dose-limiting tissues. In bone marrow the basement membrane is absent and the blood circulation is functionally open. Therefore, blood plasma and marrow ECS maintain equal concentrations of labeled immunoglobulins. A combination of factors including intravenous administration, slow absorption into most tissues, slow breakdown and elimination of labeled immunoglobulin, and rapid entry into bone marrow ECS as well as known radiosensitivity of marrow led the authors to expect this tissue would prove to be the primary tissue at risk for systemic monoclonal antibody therapy. They have developed and applied in a Phase I clinical study of ^{131}I labeled CEA antibody a procedure for estimation of radiation dose to red bone marrow. Serieal measurements of blood plasma and total body retention are carried out. Binding of labeled antibody to the cellular components of blood is verified to be very low. They have observed bone marrow depression at doses greater than 400 rad. If no special procedures are used to reconstitute marrow after radiation treatment, this level represents a much greater than generally recognized limitation to radiolabeled monoclonal antibody therapy. 25 references, 4 tables.

25897 (CONF-851113—, pp 545-561) **Dose point kernels for beta-emitting radioisotopes.** Prestwich, W.V.; Chan, L.B.; Kwok, C.S.; Wilson, B. (McMaster Univ., Hamilton, Ontario). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Knowledge of the dose point kernel corresponding to a specific radionuclide is required to calculate the spatial dose distribution produced in a homogeneous medium by a distributed source. Dose point kernels for commonly used radionuclides have been calculated previously using as a basis monoenergetic dose point kernels derived by numerical integration of a model transport equation. The treatment neglects fluctuations in energy deposition, an effect which has been later incorporated in dose point kernels calculated using Monte Carlo methods. This work describes new calculations of dose point kernels using the Monte Carlo results as a basis. An analytic representation of the monoenergetic dose point kernels has been developed. This provides a convenient method both for calculating the dose point kernel associated with a given beta spectrum and for incorporating the effect of internal conversion. An algebraic expression for allowed beta spectra has been accomplished through an extension of the Bethe-Bacher approximation, and tested against the exact expression. Simplified expression for first-forbidden shape factors have also been developed. A comparison of the calculated dose point kernel for ^{32}P with experimental data indicates good agreement with a significant improvement over the earlier results in this respect. An analytic representation of the dose point kernel associated with the spectrum of a single beta group has been formulated. 9 references, 16 figures, 3 tables.

25898 (CONF-851113—, pp 574-586) **Preliminary model of the circulating blood for use in radiation dose calculations.** Poston, J.W.; Aissi, A.; Hui, T.Y.; Jimba, B.M. (Texas A & M Univ., College Station). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Currently there is a need for a dosimetric model to describe the circulatory system in an adult human. This need exists because of the increasing number of radiopharmaceuticals used in nuclear medicine which are confined primarily to the blood, have short half-lives, and irradiate the body as they move through the circulatory system. A preliminary design of such a system has been completed based on a review of the literature. This model has been incorporated into the MIRD phantom and calculations have been completed for a number of exposure situations. The model will be discussed in detail and preliminary results of calculations using this model will be presented. 11 references, 7 tables.

25899 (CONF-851113—, pp 587-612) **Simple dynamic model for calculating radiation absorbed dose to the bladder wall.** Chen, C.T.; Harper, P.V.; Lathrop, K.A. (Univ. of Chicago Medical Center, IL). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

A simple model of estimating the radiation absorbed dose to the inner surface of the bladder wall has been developed. This model assumes a spherical bladder shape and takes into account the dynamic nature of the bladder filling and emptying processes. The model also allows for variable voiding schedules and a residual fraction after each voiding. Formulas for estimating the radiation absorbed dose to the bladder wall are derived analytically using classical dose calculation approaches. Two commonly used radiopharmaceuticals, F-18 labeled 2-[F-18]fluoro-2-deoxy-D-glucose (F-18-FDG) for positron imaging and Tc-99m labeled diethylenetriaminepentaacetic acid (Tc-99m-DTPA) for single-photon renal imaging, are employed to demonstrate the utility of this simple model in determining optimal strategies to achieve dose reduction. Computer simulation studies have been performed to investigate the effects of various initial bladder volumes, urine production rates, residual fractions, and voiding schedules. A general recommendation is a comfortably large initial bladder volume, a high urine production rate, and voiding after most of the activity has accumulated in the bladder, when possible. After the first few voidings at their strategically chosen times, more frequent voidings and smaller residual fractions sometimes can also reduce the radiation absorbed dose. 15 references, 14 figures, 1 table.

25900 (CONF-851113—, pp 613-627) **Age- and sex-dependent model for estimating radioiodine dose to a normal thyroid.** Killough, G.G.; Eckerman, K.F. (Oak Ridge National Lab., TN). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

This paper describes the derivation of an age- and sex-dependent model of radioiodine dosimetry in the thyroid and the application of the model to estimating the thyroid dose for each of 4215 patients who were exposed to ^{131}I in diagnostic and therapeutic procedures. In most cases, the available data consisted of the patient's age at the time of administration, the patient's sex, the quantity of activity administered, the clinically-determined uptake of radioiodine by the thyroid, and the time after administration at which the uptake was determined. The metabolic model is of the form $A(t) = K[\exp(-\mu_1 t) - \exp(-\mu_2 t)]$ (μCi), where $\mu_1 =$ λ/sub r/ - λ/sub i//sup b/ (i = 1, 2), λ/sub r/ is the radiological decay-rate coefficient, and λ/sub i//sup b/ are biological removal rate coefficients. The values of λ/sub i//sup b/ are determined by solving a nonlinear equation that depends on assumptions about the time or maximum uptake an the eventual biological loss rate (through which age dependence enters). The value of K may then be calculated from knowledge of the uptakes at a particular time. The dosimetric S-factor (rad/μCi-day) is based on specific absorbed fractions for photons of energy ranging from 0.01 to 4.0 MeV for thyroid masses from 1.29 to 19.6 g; the functional form of the S-factor also involves the thyroid mass explicitly, through which the dependence on age and sex enters. An analysis of sensitivity of the model to uncertainties in the thyroid mass and the biological removal rate for several age groups is reported. 12 references, 5 figures, 5 tables.

25901 (CONF-851113—, pp 648-660) **Radiolabeled blood cells: radiation dosimetry and significance.** Thakur, M.L. (Thomas Jefferson Univ., Philadelphia, PA). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Over the past few years blood cells labeled with In-111 have become increasingly useful in clinical diagnosis and biomedical research. Indium-111 by the virtue of its physical characteristics and ability to bind to cell cytoplasmic components, provides an excellent cell tracer and thereby, allows investigators to monitor in vivo cell distribution by external imaging and help determine a course of regimen in treating life threatening diseases. Due to natural phenomena such as margination, blood pool, and reticuloendothelial cell activity, in the normal state, depending upon the cell type and the quality of cell preparations, 30%-50% of the administered radioactivity is immediately distributed in the liver, spleen and bone marrow. Over a period of time the radioactivity in these organs slightly increases and decays with a physical half-life of In-111. The resulting radiation dose to these organs ranges between 1-25 rads/mCi In-111 administered. The authors have developed a new In-111 labeling technique which preserves platelet ultrastructure and shown that human lymphocytes labeled with In-111 in mixed leukocytes preparations a) are only 0.003% of the total -body lymphocytes population and b) are killed. The consequence if any may be considered insignificant, particularly because 5.6% metaphases from normal men and 6.5% metaphases from normal women in the US have at least one chromosome aberration. Calculations have shown that the risk of fatal hematological malignancy, over a 30 year period, in recipients of 100 million lymphocytes labeled with 100 μCi In-111 is 1/million patients studied. This risk is less than 0.025% of the 1981 spontaneous cancer patient rate in the country. 32 references, 10 tables.

25902 (CONF-851113—, pp 673-680) **Variations in absorbed doses from $^{5}1Cr$ in investigations with labelled erythrocytes.** Roth, P.; Werner, E.; Henrichs, K.; Elsasser, U.; Kaul, A. (Gesellschaft fuer Strahlen- und Umweltforschung, Frankfurt am Main, Germany, F.R.). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

In nuclear medicine ^{51}Cr labelled red blood cells are used to determine erythrocyte volume, red cell survival, or the site of red cell destruction. The author examined the variations in adsorbed doses from ^{51}Cr in 77 patients with various diseases in whom erythrokinetic investigations were performed for diagnostic purposes. Autologous erythrocytes were incubated with Na_2CrO_4 (37 kBq (1.0 uCi) ^{51}Cr/kg body weight) and injected intravenously. ^{51}Cr activity in blood was then followed for 10 weeks. ^{51}Cr activity over liver, spleen, and sacrum and whole-body retention of ^{51}Cr were measured for the same period. A compartmental model was assumed to describe the kinetics of ^{51}Cr tagged to red blood cells. It is a noncirculating linear model with the compartments represented by organs (spleen, liver, bone, residual body) rather than physiological compartments. The computer program SAAM-25 was used to provide the kinetic parameters and the organ retention functions. From the cumulated activities of the source regions, organ doses and effective dose equivalents were calculated according to the MIRD concepts. The highest organ doses were found for spleen, liver, and red marrow. The calculated dose values for ^{51}Cr found in this study confirm only partly the values reported in ICRP Publication 17, but are higher up to a factor of 9 for some organs. 16 references, 1 figure, 3 tables.

25903 (CONF-851113—, pp 681-690) **Radiobiological half-lives for carbon-14 and hydrogen-3 leucine in man.** Classic, K.L.; Schwenk, W.F.; Haymond, M.W. (Mayo Clinic and Foundation, Rochester). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

In vivo estimates of protein metabolism in many are often made by oral or intravenous administration of leucine or its ~-ketoacid, ~-ketoisocaproate, labeled with ^{14}C or ^{3}H. Previous estimates of radiation dose from such tracers have been based on the measurement of $^{14}CO_2$ in breath. Using measurements of the decay of ^{3}H or ^{14}C leucine from plasma proteins, longer biological half-lives for these compounds were obtained. The estimated total-body radiation absorbed dose is 0.97 mrad/uCi for [1-^{14}C]KIC (or [1-^{14}C]leucine) and 0.11 mrad/$^{+}$Ci for]4,5-^{3}H]leucine (or [^{3}H]KIC). Assuming administered doses of 100 μCi each, the total-body radiation absorbed dose is still well within the limits set by the FDA for Radioactive Drug Research Committees. 12 references, 3 figures, 3 tables.

25904 (DOE/ER/60084—6) **Development of a new osmium-191: Iridium-191m radionuclide generator: Final report.** Treves, S.; Packard, A.B. (Children's Hospital Corp., Boston, MA (USA)). 31 Dec 1986. Contract AC02-82ER60084. 43p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87007736.

The use of iridium-191m (T/sub 1/2/ = 5s) for first-pass radionuclide angiography offers the potential advantages of lower patient radiation dose and the ability to obtain repeated studies without interference from the previously administered radioisotope. These potential advantages have been offset by the absence of satisfactory ^{191}Os-/sup 191m/Ir generators. The goal of this project was, therefore, the development of an ^{191}Os-/sup 191m/Ir generator that would be suitable for clinical use. This goal was first sought through modifications of an existing ^{191}Os-/sup 191m/Ir generator design (i.e., changes in the ion exchange material and eluent) but these changes did not lead to the required improvements. A new approach was then undertaken in which different chemical forms of the ^{191}Os parent were evaluated in prototype generators. The complex trans-dioxobisoxalatoosmate (VI) led to a generator with higher /sup 191m/Ir yield (25 to 30%/mL) and lower ^{191}Os breakthrough ($<5 \times 10^{-4}$%) with a more physiologically compatible eluent than had been previously achieved. Toxicity studies were conducted on the eluate and an IND subsequently obtained. While this is not a final solution to the problem of developing a clinically acceptable ^{191}Os-/sup 191m/Ir generator, the "oxalate" generator is the most significant improvement of the ^{191}Os-/sup 191m/Ir generator to date and will be used in an expanded program of clinical studies. 16 refs., 16 tabs.

25905 (DOE/ER/60542—T1) **[Perfusion imaging: Instrumentation, modeling, and radiopharmaceuticals: Report of the scientific meeting: Final technical report].** Graham, M.M. (Society of Nuclear Medicine, New York (USA)). 1987. Contract FG02-87ER60542. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007363.

This meeting provided an excellent overview of the state-of-the-art in perfusion imaging from the viewpoints of mathematical data analysis, radiochemical synthesis and evaluation, and instrumentation physics. The participants and audience had an opportunity to see how each of these aspects is essential for continued progress in this field.

25906 (UCRL—96368) **Discussion of possible content of an IAEA [International Atomic Energy Agency] handbook/computer file for "Data for Medical Radioisotope Production".** Blann, M. (Lawrence Livermore National Lab., CA (USA)). Apr 1987. Contract W-7405-ENG-48. 5p. (CONF-870490—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007451.

From International Atomic Energy Agency coordinated research project on isotope production for medical applications; Tokyo, Japan (20 Apr 1987).

Several possible approaches will be put forward in order to stimulate discussion and seek consensus on the relative emphasis and format of a proposed IAEA handbook and computer file for "Data for Medical Radioisotope Production." An outline for possible chapters for non-nuclear physicists will be presented describing low, medium, and high energy reactions induced by light projectiles (e.g., n,p,α), by photons, and by heavy ions. Qualitative features would be described, typical experimental examples would be presented to illustrate each type of reaction, and examples would be presented of how well various computer codes would permit the calculation/prediction of the experimental results. We next solicit discussion of the desirability of the above, and of the format and means of compilation of a computer data file for isotope production. This should include format of experimental data, and also, whether a calculated file should be presented for production of particular isotopes from a "most wanted" list.

25907 **Phenomenological correlates of metabolic activity in 18 patients with chronic schizophrenia.** Volkow, N.D.; Wolf, A.P.; Van Gelder, P.; Brodie, J.D.; Overall, J.E.; Cancro, R.; Gomez-Mont, F. (Brookhaven National Lab., Upton, NY). *American Journal of Psychiatry;* No. 2, 151-158(Feb 1987).

Using [11C]-deoxy-D-glucose and positron emission tomography (PET), the authors measured brain metabolism in 18 patients with chronic schizophrenia to assess which of the metabolic measures from two test conditions was more closely related to the patients' differing clinical characteristics. The two conditions were resting and activation, and an eye tracking task was used. Patients with more negative symptoms showed lower global metabolic rates and more severe hypofrontality than did the patients with fewer negative symptoms. Differences among the patients were distinguished by the task: sicker patients failed to show a metabolic activation response. These findings suggest that cerebral metabolic patterns reflect clinical characteristics of schizophrenic patients.

25908 **Initial results from the Donner 600 crystal positron tomograph.** Derenzo, S.E.; Huesman, R.H.; Cahoon, J.L.; Geyer, A.; Uber, D.; Vuletich, T.; Budinger, T.F. (Donner Lab. and Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 321-325(Feb 1987). (CONF-861007—). Contract AC03-76SF00098.

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The authors describe a positron tomography using a single ring of 600 close-packed 3 mm wide bismuth germanate (BGO) crystals coupled to 14 mm phototubes. The phototube preamplifier circuit derives a timing pulse from the first photoelectron, and sends it to address and coincidence circuits only if the integrated pulse height is within a pre-set window. The timing delays and pulse height windows for all 600 detectors and the coincidence timing windows are computer adjustable. An orbiting positron source is used for transmission measurements and look-up table is used to reject scattered and random coincidences that do not pass through the source. Data can be acquired using a stationary mode for 1.57 mm lateral sampling or the two-position clam sampling mode for 0.79 mm lateral sampling. High maximum data rates are provided by 45 parallel coincidence circuits and 4 parallel histogram memory units. With two-position sampling and 1.57 mm bins, the reconstructed point spread function (PSF) of a 0.35 mm diam / sup 22/Na wire source at the center of the tomograph is circular with 2.9 mm full-width at half-maximum (fwhm) and the PSF at a distance of 8 cm from the center is elliptical with a radial fwhm of 4.0 mm and tangential fwhm of 3.0 mm.

25909 **Scintillation photon detection and event selection in high resolution positron emission tomography.** Turko, B.T.; Zizka, G.; Lo, C.C.; Leskovar, B.; Cahoon, J.L.; Huesman, R.H.; Derenzo, S.E.; Geyer, A.B.; Budinger, T.F. (Engineering Div., Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-34**: No. 1, 326-331(Feb 1987). (CONF-861007—).

From Nuclear science and nuclear power systems symposium; Washington, DC, USA (29 Oct 1986).

The scintillation photon detection and event selection subsystem for the high spatial resolution Donner 600-channel positron emission tomograph is described. The tomograph spatial resolution of better than 3.0 mm, FWHM, is obtained by using 600 closely-packed bismuth germanate 3 mm thick scintillation detectors. Each detector has its own 13.5 mm diameter photomultiplier and event selection channel, consisting of two fast pulse amplifiers, a charge integrator, a differential pulse height discriminator and precision time delay for event strobing. The event selection channel is capable of starting a timing cycle from the first photoelectric emitted from the photocathode. It is also capable of discriminating between true events and noise and of eliminating events occurring simultaneously in two adjacent channels. Adjustments of the event strobing time and two discriminator levels are performed by a computer.

25910 Heavy charged particle radiotherapy at the University of California Berkeley Laboratory. Northern California Oncology Group clinical trials. Castro, J.R.; Gademann, G.; Collier, J.M.; Linstad, D.; Pitluck, S.; Woodruff, K.; Henderson, S.; Chu, W.; Gauger, G.; Char, D. (Lawrence Berkeley Lab., CA, USA; California Univ., San Francisco, USA. School of Medicine; Heidelberg Univ., Germany, F.R. Universitaets-Strahlenklinik). *Strahlentherapie und Onkologie;* **163**: No. 1, 9-16(Jan 1987). (In German).

At the University of California Lawrence Berkeley Laboratory, patients have been irradiated for 10 years with heavy ions (He, C, Ne, Si). Due to the biologic efficacy of this type of radiation as well as the possibility of a precise dose application, the tumors can be irradiated with very high doses without exposing the surrounding tissues. The experience gained in the treatment of more than 800 patients is presented. It shows that this radiation can be used to localize tumors situated near to particularly radiosensitive organs such as skull base, paraspinal region, and the eye.

25911 Comparative serum stability of Cu-67 and In-111 chelates for diagnostic and therapeutic antibody applications. De Nardo, S.J.; Meares, C.F.; Moi, M.K.; Cole, W.C.; McCall, M.J.; De Nardo, G.L.; O'Brien, H.A. (Univ. of California, Davis, CA). *Journal of Nuclear Medicine;* **26**: No. 5, 119(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

In order to develop effective radioimmunodiagnosis and therapy, very stable chelates for chosen radionuclides must be selected and tested in the serum milieu. The usefulness of diagnostic imaging with In-111 to determine therapy with Cu-67-labeled antibodies can only be utilized if both are attached in a stable manner. Because of the kinetic lability of Cu-67, a macrocyclic chelator was synthesized (6-p-nitrobenzyl-1,4,8,11-tetra-azacyclotetradecane-N,N',N", N'''-tetraacetic acid. Cu-67 was chelated to the macrocycle (Benzyl-TETA), DTPA, and Benzyl-EDTA (BEDTA) and their in vitro stability in human serum at 37° or 10 days was compared to chelates of In-111. The initial radiochelate in serum and daily serum aliquots were evaluated by HPLC TSK-3000, and by cellulose acetate electrophoresis, pH 8.6, for 30 minutes. Cu-67 and In-111 were then labeled to monoclonal antibodies by these 3 chelators and their stability evaluated in the same manner. Some decrease in stability of the Indium-DTPA antibody preparations was noted when compared to the Indium-benzyl-EDTA antibody preparations. Cu-67, however, only produced a stable chelate for 10 days in serum with Benzyl-TETA and the Cu-670Benzyl-TETA antibody preparation had similar stability.

25912 Quantitative comparison of the regional distributions of inhaled Tc-99m DTPA aerosol and Kr-81m Gas in coal miners' lungs. Susskind, H.; Brill, A.B.; Harold, W.H. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* **26**: No. 5, 117(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

The authors compared the regional distribution of deposited Tc-99m DTPA aerosol (D) with that of Kr-81m (K) in the upright lungs of 22 coal miners with non-embolic pulmonary disease. Pixel-by-pixel distribution of K and D, as well as K/D ratios, were determined by computer analysis in each lung and presented as digitized posterior images. The lungs were also divided into 6.5-mm horizontal slices between apex and base. Values of the mean K and D counts and K/D ratio were plotted as functions of slice position. Good peripheral lung penetration was obtained for all subjects, while hot spots in the central airways were found in only one lung of a subject who smoked and had airway obstruction. Assessment of ventilation by visual evaluation of the respective images was comparable for both K and D. However, computer analysis showed that D was preferentially deposited in the basal regions of 38/44 lungs. K was preferentially distributed in the apical regions of 28/44 lungs. Increased bilateral D deposition in the basal regions was accompanied by a reduction in the apical regions of 10 subjects and in one lung of another 7 subjects. No relationship was found between aerosol deposition and ventilation/perfusion or pulmonary function measurements. In previous studies they have reported rapid aerosol clearance in coal miners. Although accurate clinical information has been obtained with D in patients with suspected pulmonary embolism, the effect of gravity on the deposition of D may limit its usefulness when quantitative information is required to evaluate subtle changes in ventilation in non-embolic pulmonary patients and for basic studies of ventilation and perfusion.

25913 Synthesis and distribution of (E)-3-C-[/sup 125/ I]iodovinyl-D-allose: A new strategy for the preparation of in vivo stable radioiodinated carbohydrates. Goodman, M.M.; Knapp, F.F. Jr. (Nuclear Medicine Group, Oak Ridge National Lab., Oak Ridge, Tennessee 37831). *Journal of Nuclear Medicine;* **26**: No. 5, 121(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Radioiodinated carbohydrates such as 2-deoxy-2-iodo-D-glucose undergo facile deiodination which precludes quantitative monitoring of glucose metabolism in tissues. Single photon tomography of the brain and heart using I-123-labeled iodovinyl branched carbohydrates designed to metabolically trap the tracer may enable the regional study of glucose metabolism in these tissues. The concept of stabilizing radioiodide as an iodovinyl moiety has now been investigated with the synthesis of a model agent, (E)-C-3-iodovinyl-D-allose. The starting material 3-C-ethynyl-1, 2:5, 6-di-0-isopropylidence-α-D-allofuranose (IV) was prepared by coupling Li-C=C-Si(CH/sub 3/)/sub 3/ (II) with the α-D-ribohexafuranose-3-ulose (I) followed by treatment with base. Hydrostannylation with (n-Bu)/sub 3/SnH gave the key intermediate, (E)-3-C-(n-Bu)/sub 3/ SnHC=CH-D-allofuranose (V). Iododestannylation of (V) by treatment with I/sub 2/ followed by hydrolysis (H/sup +/) gave (E)-3-C-iodovinyl-D-allose (VII). /sup 125/I-labeled (VII) was evaluated in rats (mean percent dose/gm). Although brain and heart uptake were low, this study demonstrates that an iodovinyl moiety stabilizes radioiodide on a sugar. Iodovinyl sugars with the active gluco configuration are presently being investigated.

25914 A new osmium-191/iridium-191m generator system. Brihaye, C.; Knapp, F.F. Jr.; Butler, T.A.; Guillaume, M. (Nuclear Medicine Group, Oak Ridge National Lab., Oak Ridge, TN). *Journal of Nuclear Medicine;* **26**: No. 5, 119(May 1985). (CONF-850611—).

From 32. annual meeting of the Society of Nuclear Medicine; Houston, TX, USA (2 Jun 1985).

Ir-191m (t/sub 1/2/ 4.96 sec) has very attractive properties for radionuclide angiography and is obtained from the long-lived (15 d) Os-191 parent. Because of the long parent half-life, generators could have an extended shelf-life (2-3 weeks) if the problems of low Ir-191m yields and rapidly increasing Os-191 breakthrough could be overcome. A new /sup 191/Os//sup 191m/Ir generator system has now been developed involving adsorption of K/sub 2/ OsCl/sub 6/ (Os-IV) on heat-treated (800°C) activated coconut carbon. This system gives consistently good Ir-191m yields of —35-40% for a 2 ml bolus and low Os-191 breakthrough of —1 x 10/sup -4/%/bolus over a 2-3 week period. In addition, this simple system does not require a scavenger column and no radiolysis has been detected after loading up to 1 Ci of Os-191. The generator is prepared from 140-230 mesh carbon and eluted with pH 2 - 0.9% NaCl containing 0.25% KI. The use of KI in the eluting solution is critical for generator performance. Yield and breakthrough do not change for up to 250 elutions of the prototype system. The generator eluent is neutralized to physiological pH and isotonicity with 0.13 M Tris buffer immediately prior to intravenous injection. No adverse effects have been observed in studies in normal adult volunteers. This new system has a long shelf-life and represents a simple, readily available source of Ir-191m for radionuclide angiography.

25915 **[^{18}F]-N-methylspiroperidol: the radioligand of choice for PETT studies of the dopamine receptor in human brain.** Arnett, C.D.; Fowler, J.S.; Wolf, A.P.; Shiue, C.Y.; McPherson, D.W. (Brookhaven National Lab., Upton, NY). *Life Sciences;* **36**: 1359-1366(1985). Contract AC02-76CH00016.

N-Methylspiroperidol, the amide N-methyl analogue of the neuroleptic spiroperidol, was radiolabeled with fluorine-18, and its distribution in the baboon brain was studied using positron emission transaxial tomography. Stereospecific binding was demonstrated in the striatum (but not in the cerebellum) by pretreatment with (-)- or (+)-butaclamol. The kinetic distribution was similar to that of [^{18}F]spiroperidol, but the absolute striatal uptake (in percent of administered dose) was at least two-fold higher. Analysis of baboon blood at 10 min after injection indicated that less than half of the radioactivity in the plasma was due to unchanged radioligand. Analysis of the metabolic stability of [^{18}F]-N-methylspiroperidol in rat brain for 4 hr indicated that, like [^{18}F]spiroperidol, it is very stable to metabolic transformation in the rat central nervous system. Striatal uptake and retention in the rat was five-fold higher for [^{18}F]-N-methyl-spiroperidol than for [^{18}F]spiroperidol. The results suggest that [^{18}F]-N-methylspiroperidol is an ideal choice for studies of the dopamine receptor in humans. 25 references, 2 figures, 2 tables.

25916 **Emission and transmission tomography: an overview.** Brownell, G.L. (Massachusetts General Hospital, Boston). *Nuclear Instruments and Methods in Physics Research;* **221**: 87-92(1984).

The development of powerful imaging techniques using X- and gamma-ray detection as well as other imaging systems using nuclear magnetic resonance and ultrasound has resulted in the ability to diagnose correctly many disease states. The fact that several imaging modalities may be used for a given condition means that hard decisions must be made as to the choice of the appropriate imaging procedure or the appropriate set of imaging procedures. Therefore it is important that each procedure extract all of the information possible. Since most imaging procedures basically identify structure or morphology, the additional information often lies in the determination of the underlying function or physiology. In the case of computed tomography, the basic imaging procedure measures a quantity closely related to electron density. By use of dual energy techniques, it is possible to observe average atomic number as well as electron density, providing further information on the tissue characteristics. Emission tomography provides useful information on many aspects of human physiology since a wide variety of radiopharmaceuticals may be employed. For this reason, ECT may assume greater importance in the future when used with other imaging techniques. 8 references, 8 figures.

5507 Microbiology

REFER ALSO TO CITATION(S) 24406, 24719

5508 Morphology

REFER ALSO TO CITATION(S) 25871

5509 Pathology

REFER ALSO TO CITATION(S) 25907, 25961

25917 **(AD-A—176319/2/XAB) Chemical warfare nerve agents. A review of cardiopulmonary pathophysiology and resuscitation. Technical report.** Franz, D.R. (Army Medical Research Inst. of Chemical Defense, Aberdeen Proving Ground, MD (USA)). Dec 1986. 27p. (USAMRICD-SP—85-109). NTIS, PC A03/MF A01.

The purpose of this document is to provide the medical research community with a digest of the open and internal literature related to cardiopulmonary pathophysiology, resuscitation, and animal modeling of chemical warfare nerve agent intoxication. Though not comprehensive, this review makes available to the reader a cross section of what research was done in this small but important part of the medical chemical defense research program between World War II and the early 1980's.

5510 Physiological Systems

25918 **Altering the axial light gradient affects photomorphogenesis in emerging seedlings of Zea mays L.** Parks, B.M.; Poff, K.L. (Michigan State Univ., East Lansing). *Plant Physiology;* **81**: No. 1, 75-80(May 1986). Contract AC02-76ER01338.

The axial (longitudinal) red-light gradient (632 nanometers) of 4 day old dark-grown maize seedlings is increased by staining the peripheral cells of the coleoptile. The magnitude of increase in the light gradient is dependent solely on the light-absorbing qualities of the stain used. Metanil yellow has no effect on the axial red-light gradient, while methylene blue causes a large increase in this light gradient. These stains did not affect growth in darkness or the sensitivity of mesocotyl elongation to red light. However, mesocotyl elongation was altered for the dark-grown seedlings stained with methylene blue when these seedlings were transplanted, covered with soil, and permitted to emerge under natural lighting conditions. These observations are consistent with the idea that there is a single perceptive site below the coleoptilar node, and suggest that this perceptive site receives the actinic light which has traveled downward through the length of the shoot from an entry point in the plant tip region.

5520 Public Health

REFER ALSO TO CITATION(S) 24884, 24889, 25787, 25788, 25792, 25793, 25794, 25795, 25796, 25797, 25798, 25799, 25800, 25801, 25802, 25997

5530 Agriculture And Food Technology

REFER ALSO TO CITATION(S) 25558, 25867

25919 **(DOE/CH/10288—4) Radiation induced changes in the cuticular hydrocarbons of the granary weevil and their relationships to desiccation and adult mortality: Annual progress report, February 15, 1986 to February 14, 1987.** Sriharan, S. (Selma Univ., AL (USA). Div. of Natural and Applied Sciences). Mar 1987. Contract FG02-86CH10288. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007590.

The effects of gamma-ray irradiation on granary weevil Sitophilus granarius was studied. Cesium-137 was investigated with regard to its effectiveness in insect disinfestation of grains. The cuticular hydrocarbons of treated and control weevils were analyzed by gas chromatography, mass spectrometry (Gc/Ms). The effects of different dose rates and Relative Humidity (RH) conditions on desiccation were studied by determining body weight and moisture loss. Observations on germination of irradiated wheat seeds were made as complementary to the above studies. The weevils of older age group were more sensitive to gamma radiation. With dose-rate exceeding .15 kGy the mortality is higher during 11 to 15 days after irradiation. While at lower dose-rates 0.01 kGy and 0.05 kGy lower age group insect tend to prolong and survive longer. Analysis of epicuticular hydrocarbons of adult Sitophilus granarius showed that hydrocarbons C_{25} to C_{33} were present in significant amount. The qualitative and quantitative analysis of irradiated and control weevils suggests that there was little qualitative but considerable quantitative differences between the hydrocarbon fraction (C_{25} to C_{33}) in these two groups. 3 refs., 6 figs., 5 tabs.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

REFER ALSO TO CITATION(S) 26183

5601 Radiation Effects

REFER ALSO TO CITATION(S) 24839

25920 (CONF-851113—, pp 1-12) **Ionizing radiation: benefits vs. risks.** Wagner, H.N. Jr. (Johns Hopkins Medical Institutions, Baltimore, MD). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

No one has been identifiably injured by radiation within the levels set by the NCRP and ICRP in 1934. This fact and the level of natural radiation (average dose 102 millirems/year) help provide standards against which the authors can view the relative increases in exposure from manmade sources of radiation. Because one person in five in the US will die of cancer from all causes, it is impossible to detect small increases in some types of cancer from radiation. A valid assumption is that any exposure to radiation carries some possibility of harm and should be kept below the level of the expected benefits. More is known about radiation toxicity than about any other potentially toxic substances. An obstacle to progress in the use of radioactive materials in biology and medicine is an exaggerated impression by the public of the risk of radiation. Several studies indicate that the public perceives the risk of radiation to be the greatest of all societal risks and at times does not distinguish peaceful from military uses of radiation. It behooves scientists and physicians to inform the public about the benefits as well as the risks of procedures involving radiation.

25921 (CONF-851113—, pp 37-51) **Physical and chemical events that follow the passage of a charged particle in liquid water.** Wright, H.A.; Hamm, R.N.; Turner, J.E.; Magee, J.L.; Chatterjee, A. (Oak Ridge National Lab., TN). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Biological effects of radiation are the result of a complicated sequence of events that begins with initial physical interactions that are complete by $\sim 10^{-15}$ s, followed by chemical interactions that begin at $\sim 10^{-11}$ s and are completed by $\sim 10^{-15}$ s, and followed by later biochemical and biological events, some of which may not occur for years. A central problem in radiation physics and radiation chemistry is to understand the details of the physical and chemical events that occur during that first microsecond following the passage of a charged particle. Significant progress has been made recently at linking early physical events with later chemical events. The authors have developed a Monte Carlo computer code to calculate the position and identity of each physical event that a charged particle (electron, proton, alpha) and all of its secondaries undergoes in traversing liquid water. The code then calculates the position and identity of each reactive chemical species (ion or radical) that is produced from these physical events and is present at 10^{-11} s, and then follows each reactant through the diffusion and chemical reaction stage of track development. This work will be discussed and examples of pictures of charged-particle tracks at various times will be shown. 11 references, 9 figures, 4 tables.

25922 (CONF-851113—, pp 52-66) **Spermatogonial cell killing by radiolabeled methionine: a comparative study of the effects of Se-17, S-35, and H-3.** Rao, D.V.; Govelitz, G.F.; Sastry, K.S.R.; Howell, R.W. (Univ. of Medicine and Dentistry of New Jersey, Newark). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Spermatogenesis in the testes of mice offers an effective experimental model to investigate the biological effects and the dosimetry of Auger electron emitters in vivo, aspects that are not yet well understood. Killing of the radiosensitive spermatogonia by intratesticularly localized radionuclides is the biological effect of interest, manifesting as reduced sperm-head population four to six weeks after the initial administration of the radionuclides. The authors present here results of a comparative study of the effects of the Auger-emitter, ^{75}Se, and the beta-emitters, ^{35}S and ^{3}H, when these radionuclides are attached to methionine, and hence distributed similarly in the testis and in the cytoplasmic protein fractions of the spermatogonial cells. The sperm-head survival is assayed on the 36th day post-injection, when the sperm-head population reaches its minimum after the initial intratesticular administration of the radionuclides. In all the three cases, the survival fractions display similar dependence on the conventionally calculated average dose to the organ. These results show the adequacy of conventional dosimetry when ^{75}Se is localized in the cytoplasm of the cells, and emphasize the relative inefficiency of Auger electrons emitted from cytoplasmic decay sites in irradiating the radiosensitive DNA in the cells. 21 references, 4 figures, 4 tables.

25923 (CONF-851113—, pp 135-147) **Quantitative clinical uptake measurements using conjugate counting.** Lathrop, K.A.; Bartlett, R.D.; Chen, C.T.; Chou, J.S.; Faulhaber, P.F.; Harper, P.V.; Stark, V.J. (Univ. of Chicago, IL). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

While the use of conjugate counting for determination of organ uptake in human subjects has been extensively described, in the present study the determination of the organ uptake of ortho-iodohippurate presented several opportunities for validation of the in vivo counting data. Ortho-iodohippurate is distributed in the extracellular space, is largely extracted on each pass through the kidneys, and is not significantly deiodinated in vivo. Thus, the kidney uptake rate should be proportional to the blood level, the appearance rate of activity in the bladder is equal to the disappearance rate from the kidneys, and direct measurement of activity in the urine after voiding provides an internal standard for imaging measurements of bladder activity. Since the activity levels in the kidneys, bladder, and remainder of the body changed fairly rapidly, especially in the first 20 to 30 minutes following injection, posterior images of the trunk including kidneys and bladder were obtained continuously using a gamma camera fitted with a diverging collimator for 30 minutes and then at intervals for several hours. Simultaneous conjugate counting determinations were made using a whole body scanning system previously described at these meetings. Imaging data corrected for decay and adjacent background were fitted by least squares methods to curves representing a sum of exponentials, and the curves were normalized to the conjugate uptake measurements. The uptake curves of the kidneys and bladder matched well with the direct measurements of the urinary excretion. Data were collected in 16 normal subjects, and the estimated absorbed dose was calculated for the kidneys, the bladder and the remainder of the body for seven radioisotopes of iodine. 4 references, 6 figures, 2 tables.

25924 (CONF-851113—, pp 155-166) **Specific absorbed fractions and S-factors for calculating absorbed dose to embryo and fetus.** Elsasser, U.; Henrichs, K.; Kaul, A.; Reddy, A.R.; Roedler, H.D. (Institute for Radiation Hygiene, Neuherberg/Muenchen, West Germany). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The variation of specific absorbed fractions from maternal tissues to embryo/fetus is investigated for four different target masses and geometries. S-factors are calculated for selected radionuclides assumed to be distributed uniformly in fetal tissues represented by spheres from 1 mg to 4 kg. As an example, the dose to fetal tissues for iodine-131 and iron-59 is estimated based on human biokinetic data for various stages of pregnancy. 24 references, 4 tables.

25925 (CONF-851113—, pp 167-180) **Radiopharmaceuticals in breast milk.** Mountford, P.J.; Coakley, A.J. (Kent and Canterbury Hospital, Canterbury, England). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

As assessment has been made of the radiological hazards to an infant following the administration of a radiopharmaceutical to a breast feeding mother. Feeding should be discontinued after administration of most I-131 and I-125 compounds, Ga-67 citrate or Se-78 methionine, and for iodinated compounds where it was possible to resume feeding, a thyroid-blocking agent should be administered. For Tc-99m compounds, pertechnetate had the greatest excretion in milk and interruptions of 12hr and 4hr were considered appropriate for pertechnetate and MAA respectively. Other Tc-99m compounds, Cr-51 EDTA and In-111 leucocytes did not justify an interruption just on the grounds of their associated excretion in milk. The ingestion hazard could be minimized by reducing the administered activity, and in some cases, by the substitution of a radiopharmaceutical with lower breast milk excretion. For Tc-99m lung and brain scans, the absorbed dose due to radiation emitted by the mother (i.e. when cuddling) was less than the ingested dose, but for a Tc-99m bone scan the emitted dose was greater. In all three cases, the emitted dose did not exceed 0 x 5 mGy for the infant in close contact to the mother for one-third of the time. For In-111 leucocytes, the emitted dose was about 2mGy, and it was concluded that close contact should be restricted to feeding times during the first 3 days after injection. 36 references, 2 figures, 5 tables.

25926 (CONF-851113—, pp 181-185) **Radiation exposure to parents nursing their child during treatment with 131-I-meta-iodobenzyl guanidine for neuroblastoma.** Marcuse, H.R.; van der Steen, J.; Maessen, H.J.M.; Hoefnagel, C.A.; Voute, P.A. (Netherlands Cancer Institute (Antoni van Leeuwenhoek Huis), Amsterdam). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

After 22 treatments involving eight patients the radiation dose equivalent received by parents is described. Patients received 1.5-5.5 GBq I-131 as MIBG by 1-24 hours infusion. Selection for therapy was made after a diagnostic examination of MIBG uptake with quantities less than 40 Mbq. The decision for treatment was based on estimations of the radiation dose delivered to the tumor and to normal organs and the general condition of the patient. The hospital is licensed to discharge patients if a number of conditions concerning the administered radioactivity are satisfied. It is shown that the dose equivalent to the parent can be kept to an acceptable level of approximately 1 mSv per treatment. This dose equivalent is mainly due to external radiation since blocking the parent's thyroid leads to negligible dose equivalent from internal contamination. 2 references, 2 figures, 1 table.

25927 (CONF-851113—, pp 186-193) **Medical concerns in the application of ultrashort-lived radionuclides.** Strauss, H.W.; Gill, J.; Miller, D.D.; Callahan, R.; Elmaleh, D. (Massachusetts General Hospital, Boston). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The dosimetry of ultrashort-lived radionuclides is dependent on the biodistribution and residence time of the materials eluted from the generator. Since the half-life of the daughter usually precludes any serious chemical manipulations, the eluates are usually infused in the chemical form available directly from the generator, typically simple ions. As a result, the factors that will define dosimetry are: (1) decay scheme of the daughter; (2) progeny of the daughter; (3) decay scheme of the parent; (4) radiocontaminants of the parent; (5) breakthrough of the parent; (6) biodistribution of the radionuclides. The half-life of the daughter is usually sufficiently short that it does not contribute significantly to the radiation burden. The half-life of the parent, associated radiocontaminants or the progeny, on the other hand, may contribute substantially to the radiation burden of the patient. Many of these agents, including osmium, germanium, and mercury have long biological half-lives and specific organ localization which contribute the radiation burden. 9 references.

25928 (CONF-851113—, pp 194-211) **Problems in radiation absorbed dose estimation from positron emitters.** Powell, G.F.; Harper, P.V.; Reft, C.S.; Chen, C.T.; Lathrop, K.A. (Univ. of Chicago Hospitals and Clinics, IL). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The positron emitters commonly used in clinical imaging studies for the most part are short-lived, so that when they are distributed in the body the radiation absorbed dose is low even though most of the energy absorbed is from the positrons themselves rather than the annihilation radiation. These considerations do not apply to the administration pathway for a radiopharmaceutical where the activity may be highly concentrated for a brief period rather than distributed in the body. Thus, high local radiation absorbed doses to the vein for an intravenous administration and to the upper airways during administration by inhalation can be expected. For these geometries, beta point source functions (FPS's) have been employed to estimate the radiation absorbed dose in the present study. Physiologic measurements were done to determine other exposure parameters for intravenous administration of O-15 and Rb-82 and for administration of O-15-CO_2 by continuous breathing. Using FPS's to calculate dose rates to the vein wall from O-15 and Rb-82 injected into a vein having an internal radius of 1.5 mm yielded dose rates of 0.51 and 0.46 (rad x g/μCi x h), respectively. The dose gradient in the vein wall and surrounding tissues was also determined using FPS's. Administration of O-15-CO_2 by continuous breathing was also investigated. Using ultra-thin thermoluninescent dosimeters (TLD's) having the effective thickness of normal tracheal mucosa, experiments were performed in which 6 dosimeters were exposed to known concentrations of O-15 positrons in a hemicylindrical tracheal phantom having an internal radius of 0.96 cm and an effective length of 14 cm. The dose rate for these conditions was 3.4 (rads/h)/(μCi/cm^3). 15 references, 7 figures, 6 tables.

25929 (CONF-851113—, pp 212-216) **Radiation dose estimates for copper-64 citrate in man.** Crook, J.E.; Carlton, J.E.; Stabin, M.; Watson, E. Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Tumor imaging agents suitable for use with positron emission tomographs are constantly sought. The authors have performed studies with animal-tumor-bearing models that have demonstrated the rapid uptake of copper-64. The radiation dose estimates for man indicate that the intravenous administration of 7.0 mCi would result in radiation doses to the kidney of 9.8 to 10.5 rads with other organs receiving substantially less radiations. 5 references, 3 tables.

25930 (CONF-851113—, pp 217-238) **N-13 labeled amino acids: biodistribution, metabolism and dosimetric considerations.** Rosenspire, K.C.; Gelbard, A.S. (Memorial Sloan-Kettering Cancer Center, New York, NY). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

With the growing interest in metabolic imaging and with the increasing number of cyclotron/PET facilities, more studies are being performed in animal and humans using short-lived positron-emitting radionuclides. Amino acids labeled either with N-13 or C-11 are one group of compounds being used to study in vivo regional organ (i.e., brain and heart) or tumor metabolism. Of the studies previously reported using C-11 or N-13 labeled amino acids (methionine, alanine, valine, glutamate, glutamine and tryptophan), imaging was restricted mainly to the organ or tissue of interest with little information obtained about the whole-bode distribution of the label. Such data are important for studying interorgan transport of amino acids and for determining accurate dosimetric measurements after intravenous injection of labeled amino acids. The goals of the authors study were to compare the distribution of several N-13 L-amino acids and N-13 ammonia in tumor-bearing mice and to determine the metabolic fate of the label in vivo. The following amino acids were enzymatically labeled using N-13 ammonia: glutamine, glutamate, methionine, α-aminobutyric acid, valine and leucine. 30 references, 2 figures, 14 tables.

25931 (CONF-851113—, pp 239-244) **Dosimetry of D- and L-enantiomers of ^{11}C-labeled tryptophan and valine.** Washburn, L.C.; Byrd, B.L.; Sun, T.T.; Crook, J.E.; Hubner, K.F.; Coffey, J.L.; Watson, E.E. Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The authors have previously reported the radiation dosimetry of ^{11}C-labeled DL-tryptophan and DL-valine, as well as clinical pancreatic imaging studies with these agents. Because of significant uptake in both normal pancreas and in pancreatic tumors (thought to be due to the presence of the D-enantiomer), differential diagnosis of pancreatic carcinoma was not feasible. High-performance liquid chromatographic (HPLC) methods were developed for rapid resolution of ^{11}C-labeled DL-tryptophan and DL-valine. Radiation dose estimates to the various organs in man were calculated for the D- and L-enantiomers of ^{11}C-labeled tryptophan and valine, based on tissue distribution data in rats. The dose estimates were sufficiently low that 20-mCi doses of each of the enantiomeric amino acids were approved by the FDA for intravenous administration to humans. 21 references, 3 tables.

25932 (CONF-851113—, pp 245-259) **Considerations for dosimetry calculations with neuroreceptor binding radioligands.** Wong, D.F.; Bice, A.N.; Beck, T.; Dannals, R.F.; Links, J.M.; Wagner, H.N. Jr. (Johns Hopkins Medical Institutions, Baltimore, MD). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Neuroreceptor binding radiotracers have unique characteristics which must be considered in absorbed dose calculations. In this article the authors outline some of the important issues to be considered such as the high specific binding to various receptor bearing tissue regions, the receptor kinetics, the specific activity of the injected ligand and the presence of competing unlabeled substances. As an example of these considerations they have shown the outline of the measurements for animal and human biodistribution data of the D2 dopamine receptor binding ligand ^{11}C-3N-methylspiperone (NMSP) and they calculated the absorbed doses for the important body organs. This includes dose estimates using various species including mice, followed by primate and human data. Because of the selective uptake of NMSP to brain regions such as the basal ganglia they calculated values specifically for these areas in the cerebellum. Since kinetic modeling and therapeutic drug monitoring employ competing unlabeled ligands such as haloperidol which alter the NMSP distribution they estimated the dose in both unblocked and cases blocked with haloperidol. In such cases the doses were about 50% lower in the blocked cases for the basal ganglia. Target organs such as the bladder using external probes and a model based upon changing urine volumes suggests a 30% decrease from mouse estimates. 13 references, 4 figures, 7 tables.

25933 (CONF-851113—, pp 260-266) **Radiation dose estimates for the arterial injection of Tc-99m labeled HSA microspheres and macroaggregated particles.** Croft, B.Y. (Univ. of Virginia, Charlottesville). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Particles of human serum albumin, such as macroaggregated albumin or microspheres, have been injected intra-arterially for the following indications: to examine tumor perfusion prior to and during chemotherapy, to examine coronary artery perfusion, and in the diagnosis of peripheral vascular disease. The region of distribution of the particles is localized according to the artery selected for injection. The radiation dose is affected by the distribution of the radioactivity in time and space and the physical parameters of the radionuclide. In addition, the radiation dose estimate takes into account the mass and geometry of the perfused volume. In certain cases, there is a significant amount of shunting of the injected particles; the radiation dose conferred by the shunted particles is to the lung tissue. 25 references, 6 tables.

25934 (CONF-851113—, pp 291-309) **Drugs that alter biodistribution and kinetics of radiopharmaceuticals.** Shani, J. (Univ. of Southern California, Los Angeles). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Target localization and organ biodistribution of radiopharmaceuticals (RPs) may be altered by non-radioactive drugs whose pharmacological mechanisms compete with the RPs for the same retention processes. Originally referred to as side effects or incompatibilities, such interactions became a major concern in evaluating Nuclear Medicine procedures, as they might cause interpretation of the latter to be without value or misleading. With accumulated experience, some interactions were intentionally included in Nuclear Medicine procedures and became an additional tool in differential diagnosis. Moreover, due to the ability of some RPs to compete with therapeutic agents, Nuclear Medicine studies shifted from anatomical-physiological to more pharmacologically-pathologically-based procedures that can also monitor the stage of disease, and follow its treatment. The aim of this review, therefore, is not only to illustrate some crucial pharmacological issues in Nuclear Medicine imaging, but to emphasize the possible input that alterations of RP biodistribution by drugs may have in achieving better and safer diagnosis, disease staging and monitoring of the patient's response to therapy. 166 references.

25935 (CONF-851113—, pp 310-318) **Variations in absorbed doses from ^{59}Fe in different diseases.** Roth, P.; Werner, E.; Henrichs, K.; Elsasser, U.; Kaul, A. (Gesellschaft fuer Strahlen - und Umweltforschung, Frankfurt am Main, West Germany). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

The biokinetics of radiopharmaceuticals administered in vivo may vary considerably with changes in organ functions. They studied the variations in absorbed doses from ^{59}Fe in 207 patients with different diseases, in whom ferrokinetic investigations were performed for diagnostic purposes. Radiation doses to the bone marrow were highest in patients with deserythropoietic anemias (mean 38 nSv/Bq, range 19 - 57 nSv/Bq) and in hemolytic anemias (mean 21 nSv/Bq, range 7 - 35 nSv/Bq), whereas lower and rather constant values were found in other diseases (mean values between 9 and 13 nSv/Bq). The highest organ doses, the greatest differences with respect to diagnosis and also the largest variations within each group of patients were found for liver and spleen (e. g. in aplastic anemia; liver: 66 nSv/Bq, range 29 - 104 nSv/Bq; spleen: 57 nSv/Bq, range 34 - 98 nSv/Bq. In iron deficiency; liver: 13 nSv/Bq range 12 - 14 nSv/q; spleen: 19 nSv/Bq, range 18 - 20 nSv/Bq). Lower organ doses and smaller variations within and between the groups of patients were found for the gonads (means 3 - 7 nSv/Bq), the kidneys (means 10 - 13 nSv/Bq), the bone (means 4 - 7 nSv/Bq), the lung (means 8 - 12 nSv/Bq), and the total body (means 6 - 8 nSv/Bq). In patients with chronic bleeding absorbed doses decrease concomitantly to the extent of blood loss. The D/sub E/ is not markedly affected by the variations in organ doses but is fairly constant for different diseases. 16 references, 1 figure, 3 tables.

25936 (CONF-851113—, pp 346-358) **Radiation absorbed dose estimate for rubidium-82 determined from in vivo measurements in human subjects.** Ryan, J. W.; Harper, P.V.; Stark, V.S.; Peterson, E.L.; Lathrop, K.A. (Univ. of Chicago, IL). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Radiation absorbed doses from rubidium-82 injected intravenously were determined in two young men, aged 23 and 27, using a dynamic conjugate counting technique to provide data for the net organ integrated time-activity curves in five organs: kidneys, lungs, liver, heart, and testes. This technique utilized a tungsten collimated Anger camera and the accuracy was validated in a prestwood phantom. The data for each organ were compared with conjugate count rates of a reference Ge-68/Ga-68 standard which had been calibrated against the Rb-82 injected. The effects of attenuation in the body were eliminated. The MIRD method was used to calculate the organ self absorbed doses and the total organ absorbed doses. The mean total absorbed doses were as follows (mrads/mCi injected): kidneys 30.9, heart walls 7.5, lungs 6.0, liver 3.0, testes 2.0 (one subject only), red marrow 1.3, remainder of body 1.3 and, extrapolating to women, ovaries 1.2. This absorbed dose to the kidney is significantly less than the pessimistic estimate of 59.4 mrads/mCi, made assuming instantaneous uptake and complete extraction of activity with no excretion by the kidneys, which receive 20% of the cardiac output. Further, in a 68 year old man the renal self absorbed dose was approximately 40% less than the mean renal self absorbed dose of the younger men. This decrease is probably related to the decline in renal blood flow which occurs with advancing age but other factors may also contribute to the observed difference. 14 references, 4 figures, 2 tables.

25937 (CONF-851113—, pp 389-398) **Biokinetics and dosimetry of ^{131}I-metaiodobenzylguanidine (MIBG).** Jacobsson, L.; Mattsson, S.; Johansson, L.; Lindberg, S.; Fjaelling, M. (Univ. of Goeteborg, Sweden). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

In connection with clinical ^{131}I-MIBG studies of patients with suspected sporadic pheochromocytoma or multiple endocrine neoplasia (MEN II), quantitative biokinetic data have been collected in order to improve the present estimates of absorbed dose to various organs and tissues as well as of the effective dose equivalent and its variation from patient to patient. The authors find considerably higher liver uptake than earlier published, but their estimates of the uptake in the thyroid and in the normal adrenal medulla show lower values than earlier reported. This results in the following absorbed dose per activity unit administered (mGy/MGq) (mean and typical range): Liver: 0.83 (0.50 - 1.2); Spleen: 0.61 (0.17 - 1.3); Salivary glands: 0.22 (0.082 - 0.41); Thyroid (blocked): 0.1; Total body: 0.082 (0.055 - 0.12). The effective dose equivalent was estimated to be 0.20 (0.1 - 0.3) mSv/MBq when the thyroid is adequately blocked. 16 references, 4 figures, 2 tables.

25938 (CONF-851113—, pp 399-408) **Probabilistic causality and radiogenic cancers.** Groeer, P.G. Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

A review and scrutiny of the literature on probability and probabilistic causality shows that it is possible under certain assumptions to estimate the probability that a certain type of cancer diagnosed in an individual exposed to radiation prior to diagnosis was caused by this exposure. Diagnosis of this causal relationship like diagnosis of any disease - malignant or not - requires always some subjective judgments by the diagnostician. It is, therefore, illusory to believe that tables based on actuarial data can provide objective estimates of the chance that a cancer diagnosed in an individual is radiogenic. It is argued that such tables can only provide a base from which the diagnostician(s) deviate in one direction or the other according to his (their) individual (consensual) judgment. Acceptance of a physician's diagnostic judgment by patients is commonplace. Similar widespread acceptance of expert judgment by claimants in radiation compensation cases does presently not exist. Judicious use of the present radioepidemiological tables prepared by the Working Group of the National Institutes of Health or of updated future versions of similar tables may improve the situation. 20 references.

25939 (CONF-851113—, pp 628-647) **Thyroid cancer in the Marshallese: relative risk of short-lived internal emitters and external radiation exposure.** Lessard, E.T.; Brill, A.B.; Adams, W.H. (Brookhaven National lab., Upton, NY). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

In a study of the comparative effects of internal versus external irradiation of the thyroid in young people, we determined that the dose from internal irradiation of the thyroid with short-lived internal emitters produced several times less thyroid cancer than did the same dose of radiation given externally. The authors determined this finding for a group of 85 Marshall Islands children, who were less than 10 years of age at the time of exposure and who were accidentally exposed to internal and external thyroid radiation at an average level of 1400 rad. The external risk coefficient ranged between 2.5 and 4.9 cancers per million person-rad-years at risk, and thus, from our computations, the internal risk coefficient for the Marshallese children was estimated to range between 1.0 and 1.4 cancers per million person-rad-years at risk. In contrast, for individuals more than 10 years of age at the time of exposure, the dose from internal irradiation of the thyroid with short-lived internal emitters produced several times more thyroid cancer than did the same dose of radiation given externally. The external risk coefficients for the older age groups were reported in the above literature to be in the range of 1.0 to 3.3 cancers per million person-rad-years-at risk. The authors computed internal risk coefficients of 3.3 to 8.1 cancers per million person-rad-years at risk for adolescent and adult groups. This higher sensitivity to cancer induction in the exposed adolescents and adults, is different from that seen in other exposed groups. The small number of cancers in the exposed population and the influence of increased levels of TSH, nonuniform irradiation of the thyroid, and thyroid cell killing at high dose make it difficult to draw firm conclusions from these studies. 14 references, 8 tables.

25940 (CONF-851113—, pp 661-672) **Assessment of the risk to patients from the labelling of leucocytes with indium-111.** Edwards, A.A.; Lloyd, D.C. (National Radiological Protection Board, Didcot, England). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Indium-111 oxine is used in diagnostic nuclear medicine to label leucocytes. A typical procedure might be to label white cells in 50 ml of blood with about 500 μCi (~ 20 MBq) of indium-111 and return them to the body. Both theoretical and experimental information from measurements of chromosome aberrations in lymphocytes show that the labelled cells receive doses of some tens of grays, mostly delivered within one to two weeks. Much of the dose is due to short range Auger electrons. The doses to organs of the body due to circulating labelled cells are much lower. The risk to the patient thus has two components, due to the low dose irradiation of body organs and the localized high dose to the labelled cells. The former is estimated using the concept of effective dose equivalent as recommended by ICRP. An effective dose equivalent of 2×10^{-2} Sv x mCi^{-1} for the above procedure was calculated making use of recent data on the distribution of the label within the body. The resulting risk of inducing a fatal cancer is calculated as about 3×10^{-4} mCi^{-1}. Attempts to evaluate the risk of leukemia and lymphatic cancer due to direct irradiation of labelled leucocytes are more difficult. If cellular doses are as high as 50 Gy, cell killing can be used to argue that the risk is much lower than the whole-body risk. For lower cellular doses an argument based on the fraction of cells irradiated is used and the risk due to the labelled cells appears to be two orders of magnitude lower than the whole-body risk. 30 references, 1 figure, 3 tables.

25941 **(CONF-861123—4) Personal characteristics relating to radium loss over a decade or more in radium dial workers.** Stebbings, J.H.; Jansen, A.; Kotek, T.J. (Argonne National Lab., IL (USA); Illinois Univ., Chicago (USA). Great Lakes Center for Occupational Safety and Health). 1986. Contract W-31109-ENG-38. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87004692.

From CEC/CEA international workshop on age-related factors in radionuclide metabolism and dosimetry; Angers, France (26 Nov 1986).

Personal habits and biological characteristics of 42 female Illinois radium workers first employed during the 1920s were analyzed in relationship to radium loss in late adult life. The 42 women met the criteria that they first were examined between 1957 and 1969 and are no longer employed, have had two or more radium body-burden measurements by gamma spectroscopy, 10-year minimum interval exists between initial and final measurements, and exhibit a RaC body burden in 1970 or later of $\geqq$.137 kBQ. High radium body burdens are associated with decreased rates of radium elimination, as previously described. However, the most powerful predictor was coffee/tea consumption, increased consumption being associated with increased rates of radium elimination and explaining

~35% of the variance. The effect persisted after deletion of smokers and subjects with x-ray evidence of bone damage. Weight/height ratios were positively associated with radium excretion. Individuals smoking cigarettes throughout the study period had significantly low rates of elimination of radium, similar to subjects with x-ray evidence of significant radiation-induced bone damage. Both smokers and subjects with x-ray evidence of radiation damage to bone had low weight/height ratios, suggesting that biological promoters of radiation damage to bone may exist. Rates of radium elimination were significantly associated with (linear) bone density, demonstrating that rates of loss of radium cannot be assumed to be independent of adult or postmenopausal bone density losses. Number of children and age of menopause did not have demonstrable effects on radium elimination. 9 refs., 2 figs., 7 tabs.

25942 (CONF-8703100—1-Summ.) Dose-response model selection for annual studies and prediction of human response levels: Summary of conclusions. Morris, M.D.; Jones, T.D. (Oak Ridge National Lab., TN (USA)). 09 Mar 1987. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007372.

From Defense Nuclear Agency workshop on the LD/sub 50/ for healthy young adults actively irradiated with low-let whole-body radiation; Arlington, VA, USA (9 Mar 1987).

Our recent work in the comparison of parametric models for use in animal radiation mortality studies is reviewed, along with predictions of lethal doses for man based on these models. 1 ref., 1 tab.

25943 (CONF-8703100—2) Data base on animal mortality. Jones, T.D. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007733.

From Defense Nuclear Agency workshop on the LD/sub 50/ for healthy young adults actively irradiated with low-let whole-body radiation; Arlington, VA, USA (9 Mar 1987).

A data base on animal mortality has been compiled. The literature on LD$_{50}$ and the dose-response function for radiation-induced lethality, reflect several inconsistencies - primarily due to dose assignments and to analytical methods and/or mathematical models used. Thus, in order to make the individual experiments which were included in the data base as consistent as possible, an estimate of the uniform dose received by the bone marrow in each treatment group was made so that the interspecies differences are minimized. The LD$_{50}$ was recalculated using a single estimation procedure for all studies for which sufficient experimental data are available. For small animals such as mice, the dose to the hematopoietic system is approximately equal to the treatment dose, but for large animals the marrow dose may be about half of the treatment dose.

25944 (CONF-8703100—3-Vugraphs) The Nagasaki reinforced concrete building dose calculations. Rhoades, W.A. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 38p. NTIS MF A01; 2; GPO Dep. File Number DE87007374.

From Defense Nuclear Agency workshop on the LD/sub 50/ for healthy young adults actively irradiated with low-let whole-body radiation; Arlington, VA, USA (9 Mar 1987).

The determination of radiation dose to personnel in the concrete buildings at Nagasaki is an important step in understanding the effects of radiation on personnel. The strategy was to calculate the sources of neutron and gamma radiation from the weapon, to calculate the intensity of radiation outside the buildings, to calculate the dose in the cells of a computational gridwork inside the building, and then to interpolate in this gridwork to find the dose at the position of each person. 5 figs., 3 tabs.

25945 (DOE/ER/60455—1) Mechanisms for radiation damage in DNA. Sevilla, M.D. (Oakland Univ., Rochester, MI (USA). Dept. of Chemistry). 1987. Contract FG02-86ER60455. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008311.

Several mechanisms are proposed for radiation damage to DNA and its constituents, and a series of experiments utilizing electron spin resonance spectrometry have been used to test the proposed mechanisms. In the past we have concentrated chiefly on investigating irradiated systems of DNA constituents. In this year's effort we have concentrated on radiation effects on DNA itself. In addition studies of radiation effects on lipids and model compounds have been performed which shed light on the only other proposed site for cell kill, the membrane.

25946 (DOE/EV/04322—T4) [Mechanisms and secondary factors involved in the induction of radiation transformation in vitro]: Comprehensive progress report. Little, J.B. (Harvard Univ., Boston, MA (USA). School of Public Health). 1 Jul 1986. Contract AC02-77EV04322. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008017.

We have previously shown that ^{125}Iododeoxyuridine (^{125}IdUrd) and ^{3}H-thymidine are more effective than x-rays in inducing malignant transformation when the results are normalized for survival. We have now observed a similar phenomenon for the induction of specific gene mutations in TK6 human lymphoblastoid cells. The results of parallel transformation experiments with tritiated water suggest that the enhanced efficiency of ^{3}H-thymidine as compared with x-rays is due to a higher RBE of the tritium beta particle for mutagenesis and transformation, rather than to the fact that the radioactive decay occurs within the DNA molecule. Studies of the cell cycle specificity for the induction of cell killing and mutagenesis by ^{125}IdUrd indicate that late S-phase cells are more radiosensitive than early S-phase cells to the localized deposition of energy characteristic of ^{125}I decay. Cellular localization studies have shown that ^{125}I decay must occur in close proximity to cellular DNA in order to produce mutations; ^{125}IdUrd was very mutagenic in cells which incorporated it into DNA, but not in cells in which it remained in the acid soluble pool. Unexpectedly, a similar result has emerged from preliminary experiments with ^{131}I (an energetic beta/gamma emitter); virtually no cytotoxicity or mutagenicity was observed when ^{131}IdUrd in the cells was not incorporated into DNA. These preliminary results suggest that, unlike ^{3}H-Thymidine, the biological effects of the two radioiodine-labeled nucleotide precursors may result largely from a transmutation/fragmentation effect. On the other hand, a low though significant frequency of transformation was associated with cell membrane exposure from ^{125}I-labeled sodium iodide. 11 refs., 6 figs., 1 tab.

25947 (N—87-16510) Potential impact of the newly proposed quality factors on space radiation protection. Wilson, J. W.; Townsend, L. W.; Cucinotta, F. A. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Jan 1987. 17p. (NASA-TM—89055; NAS—1.15:89055). NTIS, PC A02/MF A01.

The recently proposed changes in the defined quality factor hold great potential for easing some of the protection requirements from electrons and protons in the near-Earth environment. At the same time, the high Linear Energy Transfer (LET) components play an even more important role which must be further evaluated. Several recommendations are made which need to be addressed before these new quality factors can be implemented into space radiation potection practice.

25948 (ORAU—282) Radiation exposure and central nervous system cancers: A case-control study among workers at two nuclear facilities. Carpenter, A.V.; Flanders, W.D.; Frome, E.L.; Crawford-Brown, D.J.; Fry, S.A. (Oak Ridge Associated Universities, Inc., TN (USA)). Mar 1987. Contract AC05-76OR00033. 79p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007922.

A nested case-control study was conducted among workers employed between 1943 and 1977 at two nuclear facilities to investigate the possible association of primary malignant neoplasms of the central nervous system (CNS) with occupational exposure to ionizing radiation from external and internal sources. Eighty-nine white male and female workers, who according to the information on death certificates dies of primary CNS cancers, were identified as cases. Four matched controls were selected for each case. External radiation exposure data were available from film badge readings for individual workers, whereas radiation dose to lung from internally deposited radionuclides, mainly uranium, was estimated from area and personnel monitoring data and was used in analyses in lieu of the dose to the brain. Matched sets were included in the analyses only if information was available for the case and at least one of the corresponding controls. Thus, the analyses of external radiation included 27 cases and 90 matched controls, and 47 cases and 120 matched controls were analyzed for the effects of radiation from internally deposited uranium. No association was observed between deaths fron CNS cancers and occupational exposure to ionizing radiation from external or internal sources. However, due to the small number of monitored subjects and low doses, a weak association could not be ruled out. 43 refs., 1 fig., 15 tabs.

25949 (PB—87-147112/XAB) Leaf UV optical properties of rumex patientia l. and rumex obtusifolius l. in regard to a protective mechanism against solar UV-B radiation injury. Robberecht, R.; Caldwell, M.M. (Utah State Univ., Logan (USA)). Jan 1987. 13p. NTIS, PC A02/MF A01.

Effective UV attenuation in the outer leaf layers may represent an important protective mechanism against potentially damaging solar UV-B radiation. Epidermal optical properties for Rumex patientia and Rumex obtusifolius were examined on field-collected and greenhouse-grown plants. Rumex patientia, a relatively UV-B sensitive plant, has substantially higher epidermal UV transmittance than Rumex obtusifolius, which indicated that the UV-B flux at the mesophyll layer for Rumex obtusifolius by 27% after exposure to solar UV-B radiation. Flavonoid extract absorbance also increased in whole leaves of both species after solar UV-B radiation. The epidermis is not only an effective filter for UV-B radiation, but is wavelength selective, and shows a degree of plasticity in this attenuation.

25950 (PNL—6125) Historical review of personnel dosimetry development and its use in radiation protection programs at Hanford 1944 to the 1980s. Wilson, R.H. (Pacific Northwest Lab., Richland, WA (USA)). Feb 1987. Contract AC06-76RL01830. 135p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87007896.

This document is an account of the personnel dosimetry programs as they were developed and practiced at Hanford from their inception in 1943 to 1944 to the 1980s. This history is divided into sections covering the general categories of external and internal measurement methods, in vivo counting, radiation exposure recordkeeping, and calibration of personnel dosimeters. The reasons and circumstances surrounding the inception of these programs at Hanford are discussed. Information about these programs was obtained from documents, letters, and memos that are available in our historical records; the personnel files of many people who participated in these programs; and from the recollections of many long-time, current, and past Hanford employees. For the most part, the history of these programs is presented chronologically to relate their development and use in routine Hanford operations. 131 refs., 38 figs., 23 tabs.

25951 Mortality among plutonium and other radiation workers at a plutonium weapons facility. Wilkinson, G.S.; Tietjen, G.L.; Wiggs, L.D.; Galke, W.A.; Acquavella, J.F.; Reyes, M.; Voelz, G.L.; Waxweiler, R.J. (Los Alamos National Lab., NM). *American Journal of Epidemiology;* No. 2, 231-250(Feb 1987).

Mortality among 5413 white males employed for at least two years at a plutonium weapons facility was investigated to measure risks from low levels of plutonium and external radiation. Compared with US death rates, fewer deaths than expected were found for all causes of death, all cancers, and lung cancer. No bone cancer was observed. Excess of brain tumors was found for the cohort in general. Elevated rate ratios for all causes of death and all lymphopoietic neoplasms were found when employees with plutonium body burdens greater than or equal to 2 nCi were compared with those with body burdens less than 2 nCi. Increased rate ratios were also found for esophageal, stomach, colon, and prostate cancers, and for lymphosarcomas and reticulum cell sarcomas. No elevated rate ratios were noted for bone and liver cancers. When employees with cumulative exposures greater than or equal to 1 rem were compared with those with exposures less than 1 rem, elevated rate ratios were found for myeloid leukemia, lymphosarcoma and reticulum cell sarcoma, liver neoplasms, and unspecified brain tumors. No overall dose-response relationships were found for plutonium or external radiation exposures. Standardized rate ratios increased, however, as plutonium body burden levels increased for all causes, all cancers, and digestive cancers at five years induction time. Standardized rate ratios also increased as external radiation exposure categories increased for all lymphopoietic cancers and unspecified brain tumors for a two-year induction period. With the exception of analyses of combined categories of death, and perhaps of lung cancer, confidence limits were wide, indicating limited precision. These findings suggest that increased risks for several types of cancers cannot be ruled out at this time for individuals with plutonium body burdens of greater than or equal to 2 nCi.

25952 Optimization of radiation therapy, III: a method of assessing complication probabilities from dose-volume histograms. Lyman, J.T.; Wolbarst, A.B. (Lawrence Berkeley Lab., CA). *International Journal of Radiation Oncology, Biology and Physics;* No. 1, 103-109(Jan 1987).

To predict the likelihood of success of a therapeutic strategy, one must be able to assess the effects of the treatment upon both diseased and healthy tissues. This paper proposes a method for determining the probability that a healthy organ that receives a non-uniform distribution of X-irradiation, heat, chemotherapy, or other agent will escape complications. Starting with any given dose distribution, a dose-cumulative-volume histogram for the organ is generated. This is then reduced by an interpolation scheme (involving the volume-weighting of complication probabilities) to a slightly different histogram that corresponds to the same overall likelihood of complications, but which contains one less step. The procedure is repeated, one step at a time, until there remains a final, single-step histogram, for which the complication probability can be determined. The formalism makes use of a complication response function C(D, V) which, for the given treatment schedule, represents the probability of complications arising when the fraction V of the organ receives dose D and the rest of the organ gets none. Although the data required to generate this function are sparse at present, it should be possible to obtain the necessary information from in vivo and clinical studies. Volume effects are taken explicitly into account in two ways: the precise shape of the patient's histogram is employed in the calculation, and the complication response function is a function of the volume.

25953 Sensitivity to radiation and recovery of hematopoietic stem cells. Broyles, A.A. (Lawrence Livermore National Lab., CA). *Radiation Research;* No. 1, 12-18(Jan 1987).

A function is proposed to approximate the fraction of active hematopoietic stem cells that remain after a time following irradiation by X rays. The parameters in the function are determined by minimizing the root mean square (rms) deviations of the logarithms of the function from the logarithms of the experimentally measured stem cell fractions for mice. The rms deviation obtained is 10%. The zero time limit of the function depends exponentially on the dose decaying with a D0 of 0.43 Gy in contrast to the value 0.9 Gy often quoted. This value 0.43 is shown to be consistent with an LD50 of 5.86 Gy, an average of the values previously reported by Bateman et al. [Radiology 79, 1008-1014 (1962)]. No displacement of the exponential to the right is apparent.

25954 Myeloid leukemia in male RFM mice following irradiation with fission spectrum neutrons or gamma rays. Ullrich, R.L.; Preston, R.J. (Oak Ridge National Lab., TN). *Radiation Research;* No. 1, 165-170(Jan 1987).

The induction of myeloid leukemia following fission neutron irradiation was examined over the 0-80 rad dose range. Over this dose range the dose response could be described by the linear regression equation: $y = 0.94 + 0.18X$. A comparison of these data with data obtained following gamma irradiation from this study and a previous study indicated that the relative biological effectiveness for myeloid leukemia induction was 2.8. These results appear to be compatible with those reported by other investigators.

25955 **Experience in the practical application of biological indicators.** Huebner, K.F.; Littlefield, L.G.; DuFrain, R.J. (Tennessee Univ., Knoxville; Oak Ridge Associated Universities, Inc., TN). pp 17-34 of Biological indicators for radiation dose assessment. Kaul, A.; Dehos, A.; Boegl, W.; Hinz, G.; Kossel, F.; Schwarz, E.R.; Stamm, A.; Stephan, G. (eds.). Muenchen, Germany, F.R.; MMV Medizin Verl. (1986). (CONF-8312147—). Contract AC05-76OR00033.

From International workshop on biological indicators for radiation dose assessment; Reisensburg, F.R. Germany (12 Dec 1983).

A short review is given on the cellular (peripheral blood, bone marrow, spermiogram, chromosomal aberrations) biochemical (serum enzymes, thymidine, urine, amino acids and metabolites) and physical (neutron activation analysis, ESR spectroscopy) indicators of radiation exposure. The activities of the ORINS-ORAU-REAC/TS staff in studying the use of biological indicators in patients of reactor accidents are described. The usefulness of these indicators is discussed. 142 figures, 61 tables.

25956 **Hydroxypyridonate chelating agents and synthesis thereof.** Raymond, K.N.; Scarrow, R.C.; White, D.L. (to Dept. of Energy). US Patent Application 6-796,815. 12 Nov 1985. 55p. Contract AC03-76SF00098. DE87007272 NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007272.

Chelating agents having 1-hydroxy-2-pyridinone (HOPO) and related moieties incorporated within their structures, including polydentate HOPO-substituted polyamines such as spermidine and spermine, and HOPO-substituted desferrioxamine. The chelating agents are useful in selectively removing certain cations from solution, and are particularly useful as ferric ion and actinide chelators. Novel syntheses of the chelating agents are provided. 4 tabs.

25957 **Mechanisms of uv mutagenesis in yeast and E. coli.** Lawrence, C.; Christensen, R.; Christensen, J.R.; O'Brien, T. (Univ. of Rochester, NY). pp 511-520 of Cellular responses to dna damage. New York, NY; Alan R. Liss, Inc. (1983).

Experiments investigating ultraviolet light mutagenesis in either bakers' yeast, Saccharomyces cerevisiae, or E. coli have led to the following conclusions. First, cyclobutane pyrimidine dimers cause most mutations in both organisms; pyrimidine adducts, such as PyC, can account at best for only a small proportion. Eighty-six percent of forward mutations induced at the E. coli lacI locus can be abolished by photoreactivation under conditions which do not alter the level of recA induction. About 75 percent of the forward mutations induced at the CAN1 locus of yeast could be removed by photoreactivation, a value that lies within the range observed previously for the reversion of CYC1 alleles (60 percent - 97 percent). Second, about 10 percent of the lacI forward mutations are untargeted, a smaller fraction than found previously for cycl1-91 reversion in yeast. It is not yet clear whether the two species are really different in this respect, or whether the cyc1-91 reversion site is atypical of the yeast genome at large. Third, analysis of reversion frequencies of 20 mutant alleles suggests that about 10 - 25 percent of all replication errors produced by mutagenic mechanisms in UV-irradiated yeast involve additions or deletions of base-pairs, indicating that error-prone repair does not just produce substitutions. Last, the REV1 locus in yeast is concerned with the induction of frameshift mutations at some, but not all, genetic sites, just as found previously for substitution mutations. The function of the REV3 gene is more widely, though not universally, required while the function of the RAD6 gene, like that of the recA locus in E. coli, appears to be necessary for all kinds of UV mutagenesis. E. coli genes comparable to REV1 and REV3 have not yet been described, conversely, there does not yet appear to be a yeast equivalent of umuC. 13 references, 4 tables.

5603 Chemicals Metabolism And Toxicology

REFER ALSO TO CITATION(S) 24452, 24530, 24537, 24538, 24605, 25336, 25792, 25793, 25794, 25795, 25796, 25840, 25863, 25870, 25871

25958 **(AD-A—176106/3/XAB) Inhalation toxicology of fog-oil obscurant. Final report, October 1981-February 1986.** Grose, E.C.; Selgrade, M.J.; Davies, D.W.; Stead, A.J. (Environmental Protection Agency, Research Triangle Park, NC (USA). Inhalation Toxicology Div.). Dec 1986. 122p. NTIS, PC A06/MF A01.

Sixty-day-old, male and female rats were exposed by inhalation to fog-oil smoke. Mortality, LC50, subacute, and subchronic studies were performed. Mortality studies showed fog-oil smoke to be 100% lethal at 11.0 mg/L, 95% lethal at 5.0 mg/L, 20% lethal at 1.0 mg/L, and 0% lethal at 0.1 mg/L after a 6-hour exposure. The observed LC50 of fog-oil smoke after a 3.5-hr exposure was 5.2 mg/L. In the subacute and subchronic studies, rats were exposed to air, 0.2-, 0.5-, or 1.5-mg/L fog oil smoke for 3.5 hr/day, 4 days/wk for either 4 of 13 wk. Both pulmonary and systemic effects were investigated one day after the exposure ceased. For one 13-wk exposure group, animals were also examined 4 wk after the exposure. Following the subacute 4-exposure to 1.5 mg/L, a multifocal pneumonitis was observed. Lung lavage had an elevated number of polymorphonuclear leukoctes (PMNs), alveolar macrophages, and lung weights was observed after exposure to 0.5 mg/L. Pulmonary-function tests revealed an increase in end expiratory volume (EEV) after 1.5mg/L. Systemic effects after the subacute exposure were minimal. A decrease in zoxazolamine-induced paralysis time was observed following both 0.5 and 1.5 mg/L; however, no effect on pentobarbital-induced sleeping time was observed. Behavioral studies were negative, as were clinical chemistries and immune function tests.

25959 **(AD-A—176250/9/XAB) Comparative inhalation toxicology of selected materials. Final report on Phase 1.** Snipes, M.B.; Burt, D.G.; Eidson, A.F.; Hahn, F.F.; Harmsen, A.G. (Inhalation Toxicology Research Inst., Albuquerque, NM (USA)). Sep 1986. 209p. NTIS, PC A10/MF A01.

Studies are being conducted with Fischer-344 rats to determine the inhalation toxicology of a respirable power of copper-zinc alloy. Phase I involved standardization of methods, characterization of aerosols, and exposures of rats in whole-body of nose-only systems to air concentrations of 100 mg Cu-Zn/m^3, or 100 mg titanium dioxide/m^3. The titanium dioxide was included to determine if effects observed in exposed animals resulted from inhaling the Cu-Zn powder or inhaling a comparable amount of nuisance dust. Sham-exposed and shelf control rats were included. Rats were exposed 2.5 hr/day for 2 or 5 consecutive days, then killed for evaluations. Results include body weights, core temperatures, selected organ weights, hematology, clinical chemistry, and histopathology. Significant findings were 1) all rats were stressed when exposed in whole-body or nose-only exposure systems, 2) except for a greater body weight loss for rats exposed nose-only, indicators of stress were similar for the two types of exposure systems, 3) no consistent differences were seen between sham-exposed and TiO_2-exposed rats, and 4)adverse effects from exposure to Cu-Zn alloy powder included body weight loss, decreased ability to maintain body temperature (measured in rats exposed nose-only), rhinitis, and an inflammatory response in the lung.

25960 **(BNL—39576) Comparison of EPA [Environmental Protection Agency], ILO [International Labour Organisation], and World Bank guidelines for risk identification, assessment, and management of chemical emergencies.** Morris, S.C.; Moskowitz, P.D.; Fthenakis, V.M.; Hamilton, L.D. (Brookhaven National Lab., Upton, NY (USA)). Nov 1986. Contract AC02-76CH00016. 18p. (CONF-8611117—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008456.

From Annual meeting of the Society for Risk Analysis; Boston, MA, USA (9 Nov 1986).

In the wake of the Bhopal accident, the US Environmental Protection Agency, the International Labour Organisation, and the World Bank have each issued guidelines for identification, assessment, and management of risks from major hazards at industrial facilities. These different approaches are compared in both theoretical and practical perspectives. 14 refs., 5 tabs.

25961 (CONF-870376—1) **Interpretation of early lesions in the mouse lung: Fibrogenesis and tumorigenesis.** Witschi, H.P. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 35p. NTIS, PC A03. File Number DE87005329.

From Conference on inhalation toxicology: the design and interpretation of inhalation studies and their use in risk assessment; Hannover, F.R. Germany (23 Mar 1987).

Detailed analysis of cell kinetics following acute lung injury has given us some insight into possible pathogeneic mechanisms underlying chronic lung disease. Possible correlations between defective reepithelialisation and development of fibrotic changes need to be explored in future work. On the other hand certain concepts generally thought to apply to tumor promotion have been found not to be correct in mouse lung. It will be challenging to see, whether other experimental model systems of two stage carcinogenesis follow the mouse lung or the mouse skin paradigms. 52 refs., 7 figs.

25962 (CONF-870516—3) **Assay of SF_6 and spark-decomposed SF_6 for mutagenic activity in the CHO/HGPRT [Chinese hamster ovary/hypoxanthine-guanine phosphoribosyl transferase] mammalian cell system.** Kurka, K.; Griffin, G.D. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007673.

From 5. international symposium on gaseous dielectrics; Knoxville, TN, USA (3 May 1987).

The potential mutagenic (and cytotoxic) activity of SF_6 and spark-decomposed SF_6 was investigated in an in vitro mammalian cell culture system using Chinese Hamster Ovary (CHO) cells. The CHO cells were exposed to the gases in vacutainer tubes which were constantly rotated. After a 4 h exposure the mutagenic and cytotoxic activity was assayed with the CHO/hypoxanthine-guanine phosphoribosyl transferase (CHO/HGPRT) system. Results indicated that SF_6 was neither cytotoxic nor mutagenic to CHO cells. Spark-decomposed SF_6 was found to be strongly cytotoxic (-80% cell death following 4 h exposure to 2 kJ spark discharge in 60 cm^3 at 1000 torr of SF_6) but not mutagenic. Increasing spark energy increased cytotoxicity but the spark samples remained nonmutagenic. The CHO/HGPRT system was coupled with a metabolic activation (S9 fraction) system used for detecting promutagens. When exposures were carried out in the presence of S9 fraction, SF_6 was still neither cytotoxic nor mutagenic; spark-decomposed SF_6 was again strongly cytotoxic but not mutagenic. It appears that SF_6 and sparked SF_6 are neither promutagens nor direct acting mutagens in the CHO/HGPRT system. Studies have begun using a more mutagenically sensitive subclone of the CHO cells known as CHO-AS_{52}. The results of initial experiments using the CHO-AS_{52} cells remain unchanged. 9 refs., 1 tab.

25963 (CONF-870516—4) **Investigations of the toxicological action of spark-decomposed SF/sub 6/ in mammalian cells.** Griffin, G.D.; Kurka, K.; Sauers, I.; Easterly, C.E. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 7p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007672.

From 5. international symposium on gaseous dielectrics; Knoxville, TN, USA (3 May 1987).

The biological/toxicological activity of spark-decomposed SF_6 has been investigated in a cell culture assay system, using cell survival as the measure of biological activity. Spark-decomposed SF_6, at a given total spark energy, shows a stronger cytotoxic effect toward CHO (Chinese hamster ovary) cells than toward V79 (Chinese hamster lung) cells. Cytotoxicity results from a synthetic mixture (designed to mimic the byproducts produced by spark decomposition) confirmed previous mixture studies, in that the mixture was without cytotoxic activity. A spark-decomposed SF_6 sample, sparked to the appropriate energy to contain nearly the same concentrations of byproducts as the mixture, was assayed at the same time, and was found to show strong cytotoxic activity. Disulfur decafluoride (S_2F_{10}) was tested in the cytotoxicity assay system at concentrations of 100 to 5000 ppM in SF_6, all of which produced significant cytotoxicity. The CHO cells showed greater sensitivity than the V79 to the toxic action of S_2F_{10}. Heating is reported to decompose S_2F_{10}. Accordingly, a sample of S_2F_{10} was heated to 250°C for 2 h, and subsequently tested for cytotoxicity. Heating abolished the cytotoxicity. Samples of spark-decomposed SF_6 were heated as above, and tested for cytotoxic activity in comparison to samples of spark-decomposed SF_6 which were from the same sparked sample, but had not been heated. Heating significantly reduced the cytotoxicity of these samples. These data suggest that S_2F_{10} may be present in spark-decomposed SF_6 prepared in our system, and that S_2F_{10} may be a significant contributor to the overall toxicity of spark-decomposed SF_6, although there are other byproducts and/or factors which may also play a role in the cytotoxic activity of this electrically-stressed gas. 11 refs., 4 tabs.

25964 (CONF-8309248—, pp 105-126) **Direct effects of air pollutants, singly and in mixtures, on plants and plant assemblages.** Last, F.T. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

In the past most 'effects-studies' were made with single pollutants at constant concentrations greater than presentday ambient concentrations. However, because plant growth, and particularly that of roots, can be decreased by relatively small concentrations in the absence of conspicuous foliar blemishes and because ground-level concentrations are generally smaller than 30 years ago, it is urgently necessary to re-assess the position. This necessity is heightened because it is now known that threshold concentrations necessary to decrease growth are appreciably smaller than was previously thought, a decrease partly attributable to the interplay between pollutants. Some plants, which are relatively tolerant of large concentrations of pollutants, are relatively sensitive to small concentrations.

25965 (CONF-8309248—, pp 127-146) **Effects of accumulation of air pollutants in forest ecosystems.** Ulrich, B. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

From the types of air pollutants and their ways of deposition it is concluded that indirect effects due to accumulation can not be neglected. The substances which may act as acids or bases in the ecosphere are defined. The research approach to assess accumulation processes and their effects in the ecosystem rests on material balances. In a first rough balance emission rates of acid forming substances and the buffer rates in the ecosphere are compared. For some forest ecosystems deposition rates of acidity and nitrogen are dealt with; the place of acid buffering, of accumulation of heavy metals and aluminum ions, and the possible effects are discussed.

25966 (CONF-8309248—, pp 147-166) **Factors confounding evaluation of air pollution stress on forests: Pollution input and ecosystem complexity.** Bormann, F.H. (Commission of the European Communities, Brussels, Belgium; Commission of the European Communities, Ispra, Italy. Joint Research Centre). 1983. NTIS (US Sales Only), PC A18. File Number DE87751725.

From Symposium on acid deposition - a challenge for Europe; Karlsruhe, F.R. Germany (19 Sep 1983).

Based on studies around point sources, a repeatable pattern of forest decline under air pollution stress has been demonstrated. However, in forest ecosystems covering large areas of North America and receiving intermediate levels of air pollution, it has proven difficult to demonstrate stress effects clearly attributable to air pollution. Factors confounding understanding of the air pollution-forest ecosystem are a) substantial but largely unknown variability of pollutant deposition, b) problems in measuring changes or trends of change in the structure and function of ecosystems, and c) background noise present in any ecosystem. Use of circumstantial evidence in making judgements about the air pollution-forest ecosystem interaction is discussed and some recommendations for future research are made.

25967 **(DOE/ER/60150—T2) HERAP [Health and Environmental Risk Analysis Program] bibliography.** (USDOE Office of Energy Research, Washington, DC. Office of Health and Environmental Research). Mar 1985. Contract AC01-83ER60150. 33p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007748.

A listing is provided of publications and presentations made by the staff or contractors of the Health and Environmental Risk Analysis Program of the Office of Health and Environmental Research.

25968 **(GSF—29/86) Influence of phytate-, fibre-, protein- and fat-content in the diet on cadmium retention in growing chicks.** Hettich, R.; Rambeck, W.A.; Kollmer, W.E.; Zucker, H. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Abt. fuer Nuklearbiologie; Muenchen Univ. (Germany, F.R.). Fachbereich Tiermedizin). Oct 1986. 119p. (In German). NTIS (US Sales Only), MF A01. File Number DE87751731.

Feeding chicken with semi-synthetic diets compared with feed on corn-soy basis results in a up to five times higher cadmium concentration in kidneys. Because semi-synthetic diets have a lower content of phytate and fibre but a higher content of protein and fat, the influence of these parameters on cadmium retention in kidneys was studied in four experiments. Increasing fibre in semi-synthetic diets lowers cadmium concentration in kidneys to about one third. Cadmium retention can furthermore be reduced to about 20% by a higher protein content in the feed. By increasing the fat content, however, up to 45% more cadmium was retained in kidneys. These effects do occur only in semi-synthetic diets. The addition of Na-phytate does not lower cadmium retention as expected, but contraryly increases cadmium accumulation in kidneys by75 %. The influence of the food-factors examined does not fully explain the considerable difference in cadmium retention of semi-synthetic and corn-soy diets.

25969 **(NP—7751723) Distribution of bioelements in spruce ecosystems of the 'Baerhalde' (Southern Black Forest).** Raisch, W. (Freiburg Univ. (Germany, F.R.). Inst. fuer Bodenkunde und Waldrnaehrungslehre). 1983. 243p. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE87751723.

The reserves and distribution of 18 bioelements were determined in five spruce ecosystems (trees and ground vegetation) and in a pasture ecosystem. The spruce stands are 15, 25, 50, 75, and 130 years old. They cover almost a complete rotation cycle as practiced in this altitude. The mean annual increment per hectare varies from 6.6 to 8.3 solid cubic meters of standing crop. This is classified as low, whereas the degree of stocking is high. Twenty six tree compartments and in the ground vegetation the contents of N, P, K, Ca, Mg, Mn, Cu, Zn, Fe, Al, Na, Pb, Cd, Co, Cr, Ni, V, and Be were analysed and the respective dry matter-weights per hectare were calculated. The nutrient supply of the spruce stands was satisfactory for N, K, and Ca, very good for P, but critically short of Mg. Moreover, needle analysis revealed a nutrient deficiency for the micronutrients Zn and Cu. Al levels were high in the spruce needles and correlated with the exchangeable Al of the soils thus reflecting soil conditions. The heavy metals showed different distribution patterns within the ecosystems depending on their mobility in the soils as well as on the immitted far transported depositions into the Black Forest.

25970 **(NP—7751728) Reports of the Research Centre for Forest Ecosystems and Forest Damage. Vol. 3.** (Goettingen Univ. (Germany, F.R.). Forschungszentrum Waldoekosysteme - Waldsterben). 1984. 219p. (In German and English). NTIS (US Sales Only), PC A10. File Number DE87751728.

The reports of the Research Centre for Forest Ecosystems and Forest Damage deal with different investigations about the influences of air pollution on morphology of spruce and beech sprouts and on microbial and fungal populations, their biomass and activity. A subject analysis was made for all 11 papers contained in this report.

25971 (NP—7751728, pp 1-25) **Morphology of the branching of Fagus sylvatica L. as a basis for identifying anomalies of growth and crown damage.** Roloff, A. (Goettingen Univ., Germany, F.R. Inst. fuer Forstbotanik). 1984. (In German). NTIS (US Sales Only), PC A10. File Number DE87751728.

In Reports of the Research Centre for Forest Ecosystems and Forest Damage. Vol. 3.

An architecture model for Fagus sylvatica (copper-beech) is introduced. Important laws of the branching system are explained. Modifications of this system show influences of stressors and are discussed.

25972 (NP—7751728, pp 27-53) **Morphological and anatomic studies on terminal branches of damaged and healthy spruce. Interim report.** Gruber, F. (Goettingen Univ., Germany, F.R. Inst. fuer Forstbotanik). 1984. (In German). NTIS (US Sales Only), PC A10. File Number DE87751728.

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The anatomy and morphology of spruce sprouts is the item of this investigation. The differences between damaged and not damaged trees and especially their needles are discussed with the final result, that the reason for the loss of needles is not in the first phase lack of water.

25973 (NP—7751728, pp 55-67) **Application of X-ray microanalysis for ion detection in plant tissue at high spatial resolution.** Fritz, E. (Goettingen Univ., Germany, F.R. Inst. fuer Forstbotanik). 1984. (In German). NTIS (US Sales Only), PC A10. File Number DE87751728.

In Reports of the Research Centre for Forest Ecosystems and Forest Damage. Vol. 3.

The report deals with the correlation of phloem charge and in distribution ion the needles of conifers. The used method is X-ray microanalysis. The technique is introduced and the results of the trial are discussed.

25974 (NP—7751728, pp 69-129) **Analyses of spruce needles from sections 103 and 65 of the Hils region (north of Goettingen).** Ebel, B.; Rosenkranz, J. (Bochum Univ., Germany, F.R. Lehrstuhl fuer Zellmorphologie). 1984. (In German). NTIS (US Sales Only), PC A10. File Number DE87751728.

In Reports of the Research Centre for Forest Ecosystems and Forest Damage. Vol. 3.

Morphology and element content of damaged and healthy needles of the same spruce were analysed. Trees with different degree of damage were choosen and comparized. Optical microscopes and electron microscopes were used and X-ray microanalyses were carried out. The methods are introduced and the results of the trial are discussed.

25975 (NP—7751728, pp 131-134) **Structure and dynamics of basidiomycete species in damaged forest ecosystems, illustrated by the example of a spruce forest in the Hils region.** Schlechte, G. (Goettingen Univ., Germany, F.R. Inst. fuer Forstbotanik). 1984. (In German). NTIS (US Sales Only), PC A10. File Number DE87751728.

In Reports of the Research Centre for Forest Ecosystems and Forest Damage. Vol. 3.

In two spruce forests with a different degree of damage biomass production and number of basidiomycete species were determined. The results show, that stronger damaged forests produce an inferior number and biomass production of basidiomycetes, especially of mycorrhizas.

25976 (NP—7751728, pp 135-151) **Effect of acid rain on microbial population, biomass and activity.** Chet, I.; Merg, G.; Huettermann, A. 1984. NTIS (US Sales Only), PC A10. File Number DE87751728.

In Reports of the Research Centre for Forest Ecosystems and Forest Damage. Vol. 3.

Different methods for the determination of the microbiological activity in forest soils were tested. Further on the influence of different tree species and liming on the encymatic activity in soils were prooved.

25977 (NP—7751728, pp 153-158) **Role of soil and soil acidity in rhizomorph production by Armillaria spp. .** Worrall, J.J.; Huettermann, A. (Goettingen Univ., Germany, F.R. Inst. fuer Forstbotanik). 1984. NTIS (US Sales Only), PC A10. File Number DE87751728.

In Reports of the Research Centre for Forest Ecosystems and Forest Damage. Vol. 3.

Members of the Armillaria complex are damaging pathogens of conifers of Europe. The influence of soil, soil acidity and liming on these fungi are tested in pot trials. The results are discussed.

25978 (NP—7751728, pp 159-188) **Investigations of physiological changes in selected mycorrhizal fungi induced by Al ions in simulated soil solution. Interim report.** Oelbe-Farivar, M.; Huettermann, A. (Goettingen Univ., Germany, F.R. Inst. fuer Forstbotanik). 1984. (In German). NTIS (US Sales Only), PC A10. File Number DE87751728.

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The simulated acid soils had effects on all fungi investigated. Apart from the direct negative effects (effects of Al and low pH on biomass, protein content and H/sup +//OH/sup -/ ion transport), there were indirect effects on the surrounding soil, i.e. higher nitrate and ammonium uptake rates and higher lignine decomposition. The equilibrium of the biological community will be disturbed with certainty.

25979 (NP—7751728, pp 189-215) **Investigations of the physiological and biochemical reaction of selected mycorrhizal fungi to reduced oxygen partial pressure.** Bytom, A. (Goettingen Univ., Germany, F.R. Inst. fuer Forstbotanik). 1984. (In German). NTIS (US Sales Only), PC A10. File Number DE87751728.

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The growth of different mycorrhizas was tested under changing pressure of oxygen and carbon dioxide as well as enzyme activity of alcohol dehydrogenases and lactate dehydrogenases.

25980 (NP—7751728, pp 217-221) **Decomposition of / sup 14/C-labelled lignin, holocellulose and lignocellulose by mycorrhizal fungi.** Trojanowski, J.; Huettermann, A.; Haider, K. (Goettingen Univ., Germany, F.R. Inst. fuer Forstbotanik; Forschungsanstalt fuer Landwirtschaft, Braunschweig, Germany, F.R. Inst. fuer Pflanzenernaehrung und Bodenkunde). 1984. NTIS (US Sales Only), PC A10. File Number DE87751728.

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Five different species of known ecto-mycorrhizal fungi: Cenococcum geophilum, Amanita muscaria, Tricholoma aurantium, Rhizopogon luteolus and Rhizopogon roseolus were studied for their ability to metabolize the major components of plant cell walls. All strains were able to decompose /sup 14/C-labelled plant lignin, /sup 14/C-lignocellulose and /sup 14/C-DHP-lignin at a rate which was lower than the one observed for the known white rot fungi Heterobasidion annosum and Sporotrichum pulverulentum. Also /sup 14/C-(U)-holocellulose was relatively less degradable for the mycorrhizal fungi than for the white rotters. On the other hand, aromatic monomers like /sup 14/C-vanillic acid were decomposed to a much higher extent by two species of mycorrhizal fungi compared to the activity observed for Heterobasidion annosum. The results of the experiments reveal that these stains of mycorrhizal fungi are well able to utilize the major components of plant material and thus can contribute to litter decomposition in the forest floor.

25981 (ORNL—6347) **Chemical hazard information profile of triphenyl phosphite.** Faust, R.A.; Wiedow, M.A.; Daugherty, M.W.; Ross, R.H.; Leitzke, J.S. (Oak Ridge National Lab., TN (USA)). Dec 1986. Contract AC05-84OR21400. 46p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87005378.

The only human study located showed that triphenyl phosphite applied to the skin in a 1:3 dilution with cold cream for 48 h caused slight irritation, and challenge with the compound 14 days later produced a moderate sensitization reaction. The most significant health effects described in experimental animals are those affecting the nervous system. In adult rats, subacute exposure to the chemical produced gross ataxia and spinal cord neuropathy which predominantly affected the lateral and ventral columns of the lumber and sacral regions. Other symptoms included hyperexcitability and agitation after several days, muscle wasting, asymmetric gait, and hind-limb paralysis. All animals developed tail rigidity with a kinky appearance, and some animals displayed a circling behavior. The compound appeared to only weakly inhibit acetylcholinesterase activity. Single oral doses of triphenyl phosphite Gallus domesticus produced ataxia, and spinal cord and peripheral nerve histopathology. Neurotoxicity in rats, cats, and chickens indicated that triphenyl phosphite caused two distinct stages of action. Rats given s.c. injections of the chemical exhibit rapidly-developing stage or fine or coarse tremors which disappeared after a few hours. The later stage, occurring several days after treatment, caused hyperexcitability, spasticity and incoordination, followed by partial flaccid paralysis of the extremities. 135 refs., 2 tabs.

25982 (PB—87-145546/XAB) **Interactions of heavy metals with the pulmonary metabolism of (3H)benzo(a)pyrene.** Williams, S.J.; Karis, M.A.; Menzel, D.B. (Duke Univ., Durham, NC (USA). Medical Center). 1984. 18p. NTIS, PC A02/MF A01.

Published in Environmental Research 34, 212-226(1984).

To test the hypothesis that the inhalation of heavy-metal aerosols from polluted air or cigarette smoke could alter the metabolism of polycyclic aromatic hydrocarbons, isolated, ventilated, and perfused rat lungs were used to study the effects of $NiCl_2$, $CdCl_2$, and $CoCl_2$ on the pulmonary metabolism of (3)H benzo(a)pyrene (3)H BAP. Five minutes prior to removing the lungs from a rat, 100 microliter of isotonic sucrose containing 1 micromole of $NiCl_2$, $CdCl_2$, or $CoCl_2$ was instilled intratracheally. The lungs were placed in the perfusion system and washed free of blood. After 10 minutes, 5 nmole of (3)H BAP dissolved in 100 microliter of dimethylsulfoxide was introduced in the arterial circulation. After 45 minutes the lungs were homogenized and the homogenates and perfusates were extracted with ethyl acetate: (2:1, v/v) for analysis by HPLC. Binding of (3)H BAP metabolites to lung tissue was also determined. The metabolism of (3)H BAP was found to be inducible by pretreatment of rats with beta-naphthoflavone (80 mg/kg) and to be inhibited by the inclusion of metyrapone (1.0 mM) or indomethacin (0.1 mM) in the perfusate. The extent of covalent binding to lung macromolecules was proportional to the extent of metabolism of the (3)H BAP. Since heavy metals and polycyclic aromatic hydrocarbon coexist in the same atmospheric aerosols, heavy metal exposure from polluted urban or occupational air or cigarette smoking may have profound effects upon the bioactivity of a common organic carcinogen.

25983 (PB—87-146262/XAB) **Cadmium as a respiratory toxicant.** Grose, E.C.; Graham, J.A. (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). Jan 1987. 28p. (EPA—600/D-87/020). NTIS, PC A03/MF A01.

Cadmium is a major respiratory toxicant as evidenced by numerous human and animal studies. Controlled animal inhalation studies provide supporting evidence to the associations observed in epidemiological studies that Cd has the potential to cause lung fibrosis, emphysema, cancer, and kidney disease after prolonged exposure. Shorter-term exposure studies indicate that mechanisms thought to be involved in several of these chronic disease states (especially fibrosis and emphysema) are acutely activated. The evidence of toxicity is sufficiently clear that a TLV has been set and the International Agency for Research on Cancer has named Cd as a Group B1 substance (probable human carcinogen). The risk to Cd exposure is enhanced by its chemical and physical properties that result in bioaccumulation. Thus, even a low-level exposure over long periods of time would be expected to reach doses that could be toxic.

25984 (PB—87-147096/XAB) Hazard assessment using an integrated physiologically-based dosimetry-modeling approach: ozone. Miller, F.J.; Overton, J.H.; Smolko, E.D.; Menzel, D.B.; Graham, R.C. (Environmental Protection Agency, Cincinnati, OH (USA). Health Effects Research Lab.). Jan 1987. 31p. (EPA—600/D-87/040). NTIS, PC A03/MF A01.

A physiologically-based dosimetry-modeling approach can provide a framework for integrating various components of hazard assessments to obtain interspecies dose-response curves as part of the risk-assessment process. The methodology presented for developing dose-response curves is illustrated within the context of the inhalation toxicology of a ubiquitous air pollutant, ozone. Major components of the approach are discussed, including a data-based management system, the Critical Toxicity Reference System, and a physiological based dosimetry model for ozone absorption in the lower respiratory tract of mammals. Features and characteristics of the two components are discussed. When the ozone dosimetry-modeling approach is sufficiently developed, it can provide improved estimates for dose-response relationships in experimental animals, leading to improved estimates of human health risks.

25985 (PNL—6185) Feasibility studies of using the Catfish Immune System to produce monoclonal antibodies. Poston, T.M. (Pacific Northwest Lab., Richland, WA (USA)). Mar 1987. Contract AC06-76RL01830. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007949.

The objective of these studies was to determine the feasibility of using a teleost cell line to produce monoclonal antibodies. Studies were undertaken to demonstrate the production of a polyclonal response of channel catfish (Icatalurus punctatus) challenged with mycotoxins coupled to a protein carrier. Companion studies were also performed to induce a permanent cell line with catfish lymphocytes. Attempts to demonstrate a polyclonal response to haptenized mycotoxins were inconclusive. Tests to induce an immortal, permanent cell line with benzene and x-ray irradiated cells were also inconclusive. 3 refs., 13 tabs.

25986 (UCID—20977) A system for evaluation and control of materials with unknown toxicity. Stengel, J. (Lawrence Livermore National Lab., CA (USA)). Feb 1987. Contract W-7405-ENG-48. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008339.

Industrial hygienists, occupational health physicians, and industry management have an ethical, if not legal, responsibility to protect workers exposed to materials for which safe exposure limits have not yet been established. This requires a systematic method of obtaining available toxicological data and translating that information into meaningful controls that be implemented without unwarranted cost. Some practical approaches currently used at LLNL to deal with these problems are presented, along with their justifications and shortcomings. The concept of ALARA (As Low As Reasonably Achievable) is discussed in this context. 9 refs., 1 fig., 3 tabs.

25987 Methyl isocyanate: an evaluation of in vivo cytogenetic activity. Tice, R.R.; Luke, C.A.; Shelby, M.D. (Brookhaven National Lab., Upton, NY). *Environmental Mutagenesis;* 9: No. 1, 37-58(1987). Contract AC02-76CH00016.

The ability of inhaled methyl isocyanate (MIC) to induce genotoxic and cytotoxic damage in vivo was evaluated by assessing the induction of chromosomal aberrations (CAs) and sister chromatid exchanges (SCEs) in bone marrow metaphase cells, the induction of micronuclei in polychromatic erythrocytes (MN-PCEs), and the inhibition of bone marrow cellular proliferation and erythropoiesis. B6C3F1 mice were exposed to MIC by two exposure regiments: a) in two experiments, male mice only were exposed to 3, 10, and 30 ppm for 2 hr; b) in four experiments, male and female mice were exposed to 1 and 3 ppm (in one experiment, to 6 ppm, also), 6 hr per day for 4 consecutive days. The various cytogenetic endpoints were analyzed in bone marrow and peripheral blood (4-day exposure regimen only) samples taken from bromodeoxyuridine tablet-implanted animals killed 11 to 22 hr after cessation of the exposure to MIC. Exposure to MIC for 2 hr induced a significant delay in cellular proliferation but did not induce a significant increase in CAs, SCEs or in bone marrow MN-PCEs. Following exposure to MIC for 4 days, a weak but significant increase in CAs and SCEs was observed in male and in female mice. Delay in bone marrow cell proliferation was observed in male mice beginning at 3 ppm and in female mice at 6 ppm. The 4-day exposure regimen resulted also in a depressed rate of erythropoiesis, with male mice appearing to exhibit greater depression than female mice. The results demonstrate that exposure to MIC by inhalation results in bone marrow damage, indicating the systemic genotoxic/cytotoxic activity of MIC and/or reactive metabolites.

25988 Screening the potential risks of toxic substances using a multimedia compartment model: estimation of human exposure. McKone, T.E.; Layton, D.W. (Lawrence Livermore National Lab., CA). *Regulatory Toxicology and Pharmacology;* No. 4, 359-380(Dec 1986).

Managing environmental health risks requires the assessment of environmental fate, exposure, and health risk of an ever-increasing list of contaminants. The magnitude of this list precludes an experimental evaluation of each contaminant. For this reason, computer models are being used more frequently to simulate the transport and transformation of chemicals based on physical and chemical properties. This paper describes a multimedia compartment model that we have developed for screening toxic substances. This model, referred to as GEOTOX, uses a combination of physical, chemical, and landscape properties to establish the partitioning, reaction, and interphase-transport characteristics of a chemical. These properties are used to estimate concentrations in the air, soil, water, and food of a representative or generic environment. We use these concentrations in exposure-pathway models to calculate the quantities absorbed by humans; then dose-response data are used to estimate health risks. The capability of GEOTOX as a screening tool is illustrated in a sample ranking of three chemicals (i.e., 2,4,6-trinitrotoluene, hexahydro-1,3,5-trinitro-1,3,5-triazine, and benzene) being continuously added to the upper-soil compartment. We find that ranking based on both toxic potency and environmental fate can enhance the risk-management process when compared to ranking based on toxic potency alone.

25989 Lung development and postnatal survival for rats exposed in utero to a high-boiling coal liquid. Springer, D.L.; Hackett, P.L.; Miller, R.A.; Buschbom, R.L. (Pacific Northwest Lab., Richland, WA). *JAT, Journal of Applied Toxicology;* 6: No. 2, 129-133(1986). Contract AC06-76RL01830.

The study reported determines postnatal viability and development of survivors following in utero exposure to Harmarville process solvent (HPS), a wide-boiling-range (150 to > 455°C) coal liquid. For this study, 0.74 g kg^{-1} of the coal liquid was administered (by intragastric intubation) to rats from 12 to 14 dg. Offspring were evaluated for postnatal survival, growth and lung and thymus weights. Fifty-four percent of the exposed pups and 9% of the control pups died between birth and 3 days postpartum. Of the treated pups that died, 10% (6/5; pups/litters) had cleft palate, 27% (17/9) had small lungs and 33% (21/8) had both cleft palate and small lungs. No gross malformations were observed in the remaining 30% of the dead pups. Microscopic examination of lungs from HPS-treated pups revealed no evident histological abnormalities. Body, lung and thymus weights for treated animals that died were significantly less than those of controls. Surviving exposed pups weighed significantly less than control pups from 0.25 to 21 days postpartum and their thymus weights were also depressed through 21 days postpartum. These data suggest that retarded lung growth during prenatal life as a result of in utero exposure to the coal liquid contributes to a significant portion of the observed neonatal mortality. Furthermore, lung weights of survivors, although significantly lower than control values through 7 days postpartum, appeared to have recovered by 21 days postpartum.

25990 The significance of elevated levels of ozone on natural ecosystems of North America. Taylor, G.E. Jr.; Norby, R.J. (Environmental Sciences Div., Oak Ridge National Lab., Oak Ridge, TN). pp 152-175 of Evaluation of the scientific basis for oxide/oxidants standards. Lee, S.D. Pittsburgh, PA; Air Pollution Control Association (1985). Contract AC05-84OR21400.

This paper characterizes ozone (O/sub 3/) climatology in natural ecosystems of North America and discusses the consequences of sustained elevated O/sub 3/ levels on the physiology and growth of pollutant-sensitive forest trees, population genetic structure of sensitive species, forest community dynamics, and ecosystem structure and function. The analysis of O/sub 3/ air quality in the Shenandoah National Park, a representative forested ecosystem in eastern North America, shows a mean 7-hr daylight O/sub 3/ concentration during the growing season ranging from 0.04 to 0.06 ppm, with month-specific patterns of O/sub 3/ episodes and respites. Ozone concentrations and temporal patterns of O/sub 3/ air quality in the Shenandoah are not equivalent to those in either pristine or urban landscapes.

25991 **Enhancement of stability of 7β,8α-dihydroxy-9αepoxybenzo(a)pyrene by complex formation with serum albumin.** Roche, C.J.; Zinger, D.; Geacintov, N.E.; Harvey, R.G. (New York, NY). *Cancer Biochemistry and Biophysics;* **8**: 35-40(1985). Contract AC02-78EV04959;AC02-76EV02386.

The biologically active and chemically unstable metabolite of benzo(a)pyrene, 7β,8α-dihydroxy-9α,10α-epoxybenzo(a)pyrene (BPDE), binds to human serum albumin in aqueous solutions with an association constant of 2.6 x $10^5 M^{-1}$. At pH 7.2, 24°C and in 5mM sodium cacodylate buffer solution, this binding increases the lifetime of the diol epoxide by a factor of nearly 3. It is suggested that the formation of such physical complexes with proteins having hydrophobic interiors or with lipids may provide a mechanism by which highly reactive metabolites are transported from the site of metabolic synthesis to biological target molecules, in a reactive aqueous environment. 23 references, 2 figures.

25992 **Mechanisms of interaction of polycyclic aromatic diol epoxides with DNA and structures of the adducts.** Geacintov, N.E. (New York Univ., NY). *ACS Symposium Series;* **6**: No. 283, 107-124(1985).

Spectroscopic studies on complexes derived from the binding of benzo(a)pyrene-7,8-diol-9,10-epoxide (BaPDE) to DNA indicate that the conformations of the adducts can be broadly classified into two types: site I which displays most of the properties of intercalative adducts, and site II which is characterized by an orientation of the planar aromatic residues tilted closer to the axis of the helix. Both the syn and the anti diastereomers of BaPDE form unstable type I physical intercalation complexes and undergo specific and general acid catalysis to form tetraols (>90%) and covalent adducts (<10%). The biologically highly active (+) anti-BaPDE enantiomer undergoes a marked reorientation upon covalent binding to form almost exclusively site II adducts, while the less active (-) anti-BaPDE enantiomer, as well as racemic syn-BaPDE, give mixtures of site I and site II adducts. The presence of site II type of adducts appears to be correlated with high tumorigenic and mutagenic activities in this family of stereoisomeric diol epoxides. 54 references, 6 figures.

25993 **Evaluation of the ultrasonic method for solubilizing Daphnia magna before liquid scintillation counting.** Dauble, D.D.; Hanf, R.W. Jr.; Carlile, D.W. (Pacific Northwest Lab., Richland, WA). *Journal of Testing and Evaluation;* **12**: No. 6, 380-381(Nov 1984). Contract AC06-76RL01830.

Adult Daphnia magna were exposed to ^{14}C-labeled phenol and tissues analyzed for ^{14}C uptake by three methods: (1) tissue solubilizer, (2) tissue solubilizer plus sonication, and (3) sonication alone. Analysis by liquid scintillation counting revealed that measurements of total activity among treatments were not significantly different ($\alpha \leqq 0.10$) at two count levels. Sonicated samples showed less variation than tissue samples that were solubilized. 5 references, 1 table.

25994 **Polycyclic aromatic hydrocarbons in work atmospheres.** Gammage, R.B. (Oak Ridge National Lab., TN). pp 653-707 of Handbook of polycyclic aromatic hydrocarbons. Bjorseth, A. (ed.). New York, NY; Marcel Dekker, Inc. (1983).

The greatest emphasis is placed on PAH exposures that are, or are likely to be, encountered as a result of a proliferating synfuel industry. Occupational health control in environments containing PAH is a major objective of PAH measurements. The critical parameter is understanding the relationship of PAH exposures to human cancer. This needs to be coupled to an improving ability to monitor these exposures. Thus the characterization of workplace PAH is considered from the viewpoint of mutagenicity and carcinogenicity as well as individual PAH composition and its measurement. During the development of this chapter, the reader should be able to gain a better feeling for the types of spectra of PAH met within different workplace environments and the use of indicator compounds for characterizing these spectra. Attention is also given to pathways of worker exposure that are important, methods of collecting, monitoring, and analyzing the PAH therein, and the difficulties presently encountered in doing this. It is intended that the reader appreciate the balances and relationships between potential human carcinogenicity, PAH composition, and the technology sources of these PAH. 134 references.

5604 Other Environmental Pollutant Effects

REFER ALSO TO CITATION(S) 24522

25995 **(AD-A—175233/6/XAB) Hazard from intense low-frequency acoustic impulses. Final report.** Price, G.R. (Army Human Engineering Labs., Aberdeen Proving Ground, MD (USA)). Oct 1986. 15p. (HEL-TM—13-86). NTIS, PC A02/MF A01.

Published in J. of the Acoustical Society of America, Vol. 80, No. 4, 1076-1086(Oct 1986).

It was predicted that because the ear is spectrally tuned, it should be most affected by intense impulses with spectral peaks near the frequency where it is tuned best (3.0 kHz for the human ear) and progressively less affected by impulses at lower frequencies. This prediction is counter to all the DRCs for impulse noise; therefore, an adequate test is essential. In order to augment the data on hearing loss to low-spectral-frequency impulses, three groups of cats (eight, nine, and ten animals) were exposed on one occasion to 50 impulses from a 105-mm howitzer at peak SPLs of 153, 159, and 166 dB. Threshold shifts were measured electrophysiologically on the day of exposure (CTS) and following a 2-month recovery period (PTS). Maximum PTSs appeared at 4 kHz (even though the spectral peak of the impulse had been at about 100 Hz), and CTSs recovered into PTSs about half as large. Furthermore, the group data, even small CTSs tended to have a permanent component. These data raise the question as to whether or not any threshold shift persisting an hour or two after exposure to high levels should be considered tolerable. When compared with data from rifle fire exposures, the data confirmed the earlier prediction that as the spectral frequency drops, hazard declines at the rate of a little more than 3 dB/oct, contrary to the rating by existing DRCs.

25996 **(AD-A—175347/4/XAB) Long-term bioeffects of 435-MHz radiofrequency radiation on selected blood-borne endpoints in cannulated rats. Volume 1. Engineering considerations. Final report, October 1982-June 1985.** Toler, J.C.; Bonasera, S.J.; Popovic, V.P. (Georgia Inst. of Tech., Atlanta (USA). Research Inst.). Sep 1986. 74p. (GTRI-A—3440). NTIS, PC A04/MF A01.

This report details the engineering consideration of a program designed to monitor selected blood-borne hormones in male Sprague-Dawley rats exposed to 435-MHz continuous-wave radiofrequency radiation. The experimental group consisted of 100 rats housed in Plexiglas cages arrayed on the tiers of a stacked, parallel-plate circular waveguide. The power density along the circumference of the waveguide was 1.0 mW/sq cm. The control group consisted of 100 rats housed in an identical, but unenergized, colocated facility. This volume details waveguide and antenna development, cage development, and equipment and facility descriptions.

25997 **(AD-A—175901/8/XAB) Proposed iso standard determination of occupational noise exposure and estimation of noise-induced hearing impairment.** Von Gierke, H.E. (Air Force Aerospace Medical Research Lab., Wright-Patterson AFB, OH (USA)). 1986. 12p. (AAMRL-TR—86-057). NTIS, PC A02/MF A01.

Published in Basic and Applied Aspects of Noise-Induced Hearing, 621-630(1986).

Research on the relationship between noise exposure and noise-induced hearing loss has been very intense over the last 30 years, and steady progress has been made in spite of many remaining questions and unresolved problems regarding the mechanisms. For the time being, avoidance of excessive noise exposure is the only way to prevent noise-induced hearing loss; this is the reason why governments, industry, workers and their representatives have been looking for scientific exposure criteria and guidelines to prevent hazardous noise exposure as part of comprehensive hearing conservation programs. Although it was clear from the beginning that noise-induced hearing loss in a population with exactly defined noise exposure would exhibit a statistical distribution due to differences in biological susceptibility, the epidemiological statistical data were not available to describe quantitatively the difference between the percentage of people with impaired hearing in a noise-exposed group and the percentage of people in a non-noise-exposed group, i.e., the risk of noise-induced hearing impairment.

25998 **(PB—87-140653/XAB) Development of microwave-hazard-monitor calibration system.** Puranen, L. (Helsinki Univ. of Technology, Espoo (Finland). Radio Lab.). 1985. 37p. (S—163). NTIS, PC PC E03/MF E01.

A microwave-hazard-monitor calibration system was developed and tested in the anechoic chamber of the Radio Laboratory of the Helsinki University of Technology. A plane-wave field at 2.45 GHz was generated with a pyramidal horn antenna which was fed by a high-power generator delivering maximum power of 200 W. Two identical pyramidal horn antennas were constructed and their calculated and measured gains were 15.2 dB at 2.45 GHz. A short monopole was mounted on a waveguide triple-screw tuner connected to the transmitting horn for monitoring the transmitted power. Power density of 80 W/sq. m. with estimated worst-case uncertainty of plus or minus dB was generated at a distance of 2.5 meters from the aperture with 200 W input power. Two isotropic three-dimensional probes and five small two-dimensional probes were calibrated in the plane-wave field. For small two-dimensional probes, a waveguide calibration system was constructed.

25999 **(PB—87-142626/XAB) Assessment of noise impact on the urban environment: a study on noise-prediction models. Environmental health series.** Lang, J. (World Health Organization, Copenhagen (Denmark). Regional Office for Europe). 1986. 80p. (EH—9). NTIS, PC PC E04/MF E01.

The report identifies, compares, and evaluates the major methods developed in Europe and North America to predict noise levels resulting from urban-development projects. Hopefully, it will guide countries that have not yet developed their own noise-prediction models to choose the model most appropriate for their particular situation. It covers prediction methods for road traffic noise and railroad traffic noise in Austria, Czecheslovakia, France, both Germany's Hungary, Netherlands, Scandinavia, Switzerland, U.K. and USA, as well as the Commission of the European Communities, and a comparison of methods. It also covers prediction methods for industrial noise from Austria, both Germany's Netherlands, Scandinavia, and U.K., and discusses calculation methods for aircraft noise around airports.

26000 **(PB—87-145512/XAB) Measurement of small mechanical vibrations of brain tissue exposed to extremely-low-frequency electric fields.** Spiegel, R.J.; Ali, J.S.; Peoples, J.F.; Joines, W.T. (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). 1986. 14p. (EPA—600/J-86/190). NTIS, PC A02/MF A01.

Published in Bioelectromagnetics 7, 295-306(1986).

Electromagnetic fields can interact with biological tissue both electrically and mechanically. This study investigated the mechanical interaction between brain tissue and an extremely-low-frequency (ELF) electric field by measuring the resultant vibrational amplitude. The exposure cell is a section of X-band waveguide that was modified by the addition of a center conductor to form a small TEM cell within the waveguide structure. The ELF signal is applied to the center conductor of the TEM cell. The applied ELF electric field generates an electrostrictive force on the surface of the brain tissue. This force causes the tissue to vibrate at a frequency equal to twice the frequency of the applied sinusoidal signal. An X-band signal is fed through the waveguide, scattered by the vibrating sample, and detected by a phrase-sensitive receiver. Using a time-averaging spectrum analyzer, a vibration sensitivity of approximately 0.2 nmpp can be achieved. The amplitude of the brain tissue vibrational frequencies below 50 Hz; between 50 and 200 Hz resonant phenomena were observed; and above 200 Hz the amplitude fall-off is rapid.

57 HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 24864

26001 **(UCRL—95470) Emergency planning, response and assessment: a concept for a center of excellence.** Dickerson, M.H. (Lawrence Livermore National Lab., CA (USA)). 1 Oct 1986. Contract W-7405-ENG-48. 6p. (CONF-8608149—1). NTIS, PC A02/MF A01. File Number DE87000885.

From International seminars on nuclear war international cooperation: the alternatives; Erice, Italy (18 Aug 1986).

This paper discusses a general concept for a center of excellence devoted to emergency planning, response and assessment. A plan is presented to implement the concept, based on experience gained from emergency response as it relates to the nuclear and toxic chemical industries. The role of the World Laboratory in this endeavor would complement and enhance other organizations than are involved in related activities.

58 GEOSCIENCES

5801 Geology And Hydrology

REFER ALSO TO CITATION(S) 24615, 24618, 24661, 24662, 24665, 24666, 24667, 25859

26002 **(DOE/NV/10322—10) NNWSI [Nevada Nuclear Waste Storage Investigations] hole histories.** (Fenix and Scisson, Inc., Tulsa, OK (USA); Fenix and Scisson, Inc., Mercury, NV (USA)). Nov 1986. Contract AC08-84NV10322. 102p. NTIS, PC E15/MF $25.15; 1; GPO Dep. File Number DE87007583.

This report is a compilation of data from sixteen boreholes drilled under the guidance of the US Geological Survey to help identify the area's water table. The sixteen boreholes were drilled between April 1983 and November 1983 in Area 25, Nevada Test Site land and in Bureau of Land Management land adjacent to the Nevada Test Site. Data presented in the hole histories include all locations, daily activities, review of hole conditions, geophysical log lists, video tape lists, and microfiche copies of the geophysical logs run by the Fenix and Scisson, Inc. subcontractor.

26003 **(LBL—22641) Measurements of electrical conductivity for characterizing and monitoring nuclear waste repositories.** Morrison, H.F.; Becker, A.; Lee, K.H. (Lawrence Berkeley Lab., CA (USA)). Nov 1986. Contract AC03-76SF00098. 59p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007887.

The detection of major fractures is one topic of this study but another equally important problem is to develop quantitative relationships between large scale resistivity and fracture systems in rock. There has been very little work done on this central issue. Empirical relations between resistivity and porosity have been derived on the basis of laboratory samples or from well logging, but there are no comparable 'laws' for rock masses with major fracture or joint patterns. Hydrologic models for such rocks have been recently been derived but the corresponding resistivity models have not been attempted. Resistivity due to fracture distributions with preferred orientation could be determined with such models, as could quantitative interpretation of changes as fracture aperature varies with load. This study is not only important for the assessment of a repository site, but has far ranging implications in reservoir studies for oil, gas, and geothermal resources. The electrical conductivity can be measured in two ways. Current can be injected into the ground through pairs of electrodes and corresponding voltage drops can be measured in the vicinity with other pairs of electrodes. The electrical conductivity can also be measured inductively. Instead of injecting current into the ground as described in the dc resistivity method, currents can be induced to flow by a changing magnetic field. In these inductive or electromagnetic (em) methods the interpretation depends both on transmitter-receiver geometry and frequency of operation. In principle the interpretation should be more definitive than with the dc resistivity methods. Rigorous confirmation of this statement in inhomogeneous media awaits the development of generalized inversion techniques for em methods.

26004 **(LBL—23021) Some thoughts on model verification.** Narasimhan, T.N. (Lawrence Berkeley Lab., CA (USA)). Feb 1987. Contract AC03-76SF00098. 11p. (CONF-861220—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007615.

From American Geophysical Union fall meeting; San Francisco, CA, USA (8 Dec 1986).

The most powerful attribute of numerical models for simulating fluid flow in partially saturated fractured media is that they can handle arbitrarily complex problems in terms of geometry, heterogeneity and forcing functions. In contrast, analytical solutions can be only obtained for relatively simple problems. Therefore, the very power of the numerical models that is to be exploited is unnecessarily abridged if the numerical method is viewed merely as a tool for approximately solving the partial differential equation. A broader definition of verification is needed in order to exploit the power and generality of numerical models. In the ultimate, verification should be dictated by axiomatic testability. The development of self-verifying numerical models is a challenge that deserves pursuit.

26005 **(LBL—23069) Geotechnical support and topical studies for nuclear waste geologic repositories: Annual report, Fiscal Year 1986.** (Lawrence Berkeley Lab., CA (USA)). Nov 1986. Contract AC03-76SF00098. 227p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE87007903.

The multidisciplinary project was initiated in fiscal year 1986. It comprises two major interrelated parts: (1) Technical Assistance. This part of the project includes: (a) review of the progress of major projects in the DOE Office of Civilian Radioactive Waste Management Program and advise the Engineering and Geotechnology Division on significant technical issues facing each project; (b) analyze geotechnical data, reports, tests, surveys and plans for the different projects; (c) review and comment on major technical reports and other program documents such as site characterization plans and area characterization plans and (d) provide scientific and technical input at technical meetings. (2) Topical Studies. This activity comprises studies on scientific and technical topics, and issues of significance to in-situ testing, test analysis methods, and performance assessment of nuclear waste geologic repositories. The subjects of study were selected based on discussions with DOE staff. For fiscal year 1986, one minor and one major area of investigation were undertaken. The minor topic is a preliminary consideration and planning exercise for post-closure monitoring studies. The major topic, with subtasks involving various geoscience disciplines, is on the mechanical, hydraulic, geophysical and geochemical properties of fractures in geologic rock masses. The present report lists the technical reviews and comments made during the fiscal year and summarizes the technical progress of the topical studies.

26006 **(SAND—86-1122) A computational model for jointed media with orthogonal sets of joints.** Chen, E.P. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 66p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007826.

The numerical implementation of a constitutive model for jointed rock media is the subject of investigation in this report. The constitutive model is based on the continuum assumption of strain-partitioning among the elastic rock matrix and joint sets with nonlinear normal and shear responses. Rate equations for the stress-strain response of the jointed media have been formulated. A numerical incremental solution scheme to these equations has been developed. It has been implemented into the finite element code JAC as an additional material model. Input instructions and FORTRAN listings of the material model pertaining to execution of JAC on the Sandia Cray 1S are included in the Appendix. Several sample problems have bee solved for demonstration purposes. Interpretation and discussion of these results are presented.

26007 **Calibrating pollen data in climate terms: improving the methods.** Howe, S.; Webb, T. III. (National Bureau of Standards, Washington, DC). *Quaternary Science Reviews;* 2: 17-51(1983).

When properly calibrated. Holocene pollen data provide an important source of quantitative information about Holocene climates. Multiple linear regression of modern climate and pollen data allows the development of statistical calibration functions that transform percentages of certain pollen types into quantitative estimates of climate variables, and these functions, when applied to Holocene pollen data, yield estimates of climatic variables for past times. Confidence intervals for the climate variables provide estimates of the statistical errors. These interval estimates are based upon the following statistical assumptions: (1) the regression model is appropriate; (2) the errors in measuring the climate variables are independent, normally distributed and have constant variance; and (3) no outliers are present. The authors outline the steps to be followed in calculating calibration functions, including (1) selecting the calibration region; (2) selecting a pollen sum; (3) analyzing scatter diagrams of a given climate variable against each pollen type; (4) deleting outliers and transforming pollen data; (5) performing the regression; and (6) testing the appropriateness of the statistical assumptions. The authors used available computer programs for most of this study. In addition, we developed new software to compute the Moran statistic to test for spatial autocorrelation among the regression residuals, using the dual of the Voronoi diagram to describe the spatial relationships among the sites. In order to illustrate the sequence of procedures, the authors used data from the lower peninsula of Michigan to develop a calibration function for July mean temperature and then used Holocene pollen data from central lower Michigan to estimate past temperatures.

5802 Geophysics

REFER ALSO TO CITATION(S) 24545, 24619, 24620

26008 **(NUREG/CR—4822) Broad band seismic data analysis, September 1984-September 1986.** Carter, J.A.; Barstow, N.; Sutton, G.H.; Pomeroy, P.W. (Rondout Associates, Inc., Stone Ridge, NY (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Safety). Apr 1987. 98p. NTIS, PC A05/MF A01 - GPO. File Number TI87900628.

This report contains a detailed description of the SRNY station including its response function, description of the techniques and software used to analyze the data, and evaluations of both the station and processing methods. The station was evaluated through noise studies under both quiet and noisy conditions; its detection and location thresholds; and the frequency, duration, and causes of data loss. The report has been divided into three main sections. The first section gives a description of the broad band digital seismic station SRNY installed near the Rondout Associates, Incorporated (RAI) offices in Stone Ridge, NY. Included in the discussion are the system response functions and an analysis of the causes of data loss. The second section gives details of the data analysis methods used in studying broad band and array data. Although several methods have been studied, much of this section is devoted to the adaptive polarization methods which has shown promise as a single station location tool. The final section examines the noise characteristics at SRNY during both quiet and noisy conditions and compares these levels to the Regional Seismic Test Network Station RSNY in the Adirondack Mountain Region of northern New York. The detection and location capabilities of SRNY are also described and single-station locations at SRNY, as well as RSNY, are compared to network locations.

26009 (NUREG/CR—4852) **The Meers Fault: Tectonic activity in southwestern Oklahoma.** Ramelli, A.R.; Slemmons, D.B.; Brocoum, S.J. (Nevada Univ., Reno (USA). Center for Neotectonic Studies; Weston (Roy F.), Inc., Washington, DC (USA); Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Safety). Mar 1987. 56p. NTIS MF A01- GPO. File Number TI87900569.

The Meers Fault in Southwestern Oklahoma is capable of producing large, damaging earthquakes. By comparison to historical events, a minimum of M = 6-3/4 to 7-1/4 could be expected. The most recent surface rupturing event occurred in the late Holocene, and it appears that one or more pre-Holocene events preceded it. Surface rupture length is at least 37 km. Displacements comprising the present-day scarp have left-lateral and high-angle reverse components. Vertical separation of the ground surface reaches 5 m, while lateral separation exceeds the vertical by a ratio of about 3:1 to 5:1, reaching about 20 m. Individual events apparently had maximum displacements of several meters. The Meers Fault may be part of a larger active zone. Based on surface expressions, the Washita Valley, Oklahoma and Potter County, Texas Faults may also have ruptures during the late Quaternary, although not as recently as the Meers Fault. Low sun angle photography in Southwestern Oklahoma revealed no evidence of fault activity, other than that of the Meers Fault, although activity may be concealed by poor preservation or ductile surface deformation. This suggests that additional areas of activity may be sparse and rupture infrequently.

26010 (ORNL—15858, pp 1-18) **Seismic exposure comparison report.** Jul 1985. NTIS, PC A. File Number DE87002691.

In Seismic exposure comparison report and spectra report: final report.

A seismic exposure (probabilistic seismic hazard) analysis was conducted for the LLNL site and is termed here the LLNL/WCC study. The LLNL/WCC study was based on recently completed geology and seismicity studies and included sensitivity analyses that showed the effect of various attenuation relationships on the final results, the contribution of the various seismic sources to the total seismic hazard at the site, the contribution of various earthquake magnitudes to the total hazard at the site, and the confidence bounds on the annual probability of exceedance. Another seismic hazard analysis was conducted for the LLNL site (TERA) that was based on available data in the literature and then on-going studies conducted by LLNL. Alternative source-modeling techniques were used in this analysis (seismic source zones versus faults), with weighting factors applied to each technique. The uncertainty in some input parameters was treated probabilistically (e.g. slip rates for particular faults), while single estimates were made for other parameters (e.g. maximum magnitude, ground motion attenuation relationship). The TERA mean hazard curve is about a factor of 2 lower than the mean curve form the LLNL/WCC study. The objective of the present study is to determine the principal reasons for this difference and to quantify the extent to which various parameters contribute to the difference. By so doing, it should be possible to reconcile the two studies. This report first summarizes the details of the differences between the TERA and LLNL/WCC studies. Next, the impact of the principal differences on the seismic hazard results are evaluated. 7 references.

26011 (SAND—85-2604) **Design of the shell project Seafloor Earthquake Measurement System (SEMS).** Hickerson, J.P.; Lopez, A.A. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 106p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007946.

A new generation system which measures strong motion in marine sediments has been developed and deployed. The system consists of three subsystems: a seafloor data acquisition package and two shipboard packages that command and record data from the seafloor package. Communication between the two systems is via an acoustic telemetry system. The seafloor unit is powered by lithium batteries and has an operational life of four years. The seafloor unit is microprocessor controlled and uses a three-axis accelerometer package to continuously measure sediment motions from .001 to 10 g's. These data are digitized at a 100 hertz rate and, if they meet the preestablished event selection criterion, they are stored in an eight-million bit, nonvolatile, magnetic bubble memory. In addition to recording seismic data, the shipboard subsystem can monitor the status of the seafloor package and change the operating characteristics, if necessary. The paper describes the design, development, and deployment of the Seafloor Earthquake Measurement System. 10 refs., 17 figs., 4 tabs.

26012 **Perturbation theory for Love waves in anelastic media.** Madja, G.; Chin, R.C.Y.; Followill, F.E. (Brown Univ., Providence, RI). *Geophysical Journal of The Royal Astronomical Society;* **80**: 1-34(1985). Contract W-7405-ENG-48.

The authors give a systematic formulation and a rigorous justification of a perturbation technique for the computation of the eigenvalues and eigenfunctions of Love waves (and toroidal oscillations by an appropriate change for variables) in an anelastic medium with a constitutive law modelling geophysical media of current interest such as the Kelvin-Voigt Solid, the Maxwell Solid, the Standard Linear Solid, and the Standard Linear Solid with a continuous spectrum of relaxation times. They develop expressions relating the eigenvalues of eigenfunctions for Love waves in a continuously varying vertically stratified anelastic half-space to the corresponding elastic eigenvalues and eigenfunctions. Analytically, their correspondence principle has the form of a regular perturbation expansion in terms of a parameter epsilon for both the eigenvalues and eigenfunctions. The identification of epsilon is motivated by the dissipativity principle of viscoelasticity theory. Moreover, they show that their correspondence principle applies respectively only in the high and low frequency range for the Maxwell and Kelvin-Voigt Solids. Outside of the applicable range of frequencies, their correspondence principle yields no useful information. For the family of Standard Linear Solids it is uniformly applicable for all non-zero frequencies. They also derive an explicit formula to estimate the radius of convergence of their perturbation expansions. This estimate of the radius of convergence for each eigenvalue and eigenfunction is functionally defined by the constitutive model for the anelastic medium. The estimate is frequency dependent and depends on the separation distance between the eigenvalue and the remainder of the spectrum of the corresponding elastic problem.

5803 Mineralogy, Petrology, And Rock Mechanics

REFER ALSO TO CITATION(S) 24515, 24656, 24661, 24663, 24667

26013 (LBL—19515) **Models for calculating fluid flow in randomly generated three-dimensional networks of disc-shaped fractures: Theory and design of FMG3D, DISCEL, and DIMES.** Gilmour, H.M.P.; Billaux, D.; Long, J.C.S. (Lawrence Berkeley Lab., CA (USA)). Sep 1986. Contract AC03-76SF00098. 157p. NTIS MF A01; 2; GPO Dep. File Number DE87007910.

A model for steady fluid flow in three-dimensional random networks of fractures has been developed. In this model, the fractures are disc-shaped discontinuities in an impermeable matrix. The fracture discs can be arbitrarily located within the rock volume and can have any desired distribution of aperture, radius orientation, and density. Thus, where the disc model is appropriate it is possible to calculate flow through fracture networks which are statistically similar to those that occur in nature. After the desired fractures are specified, the intersections (nodes) between these discs (elements) are identified and the boundary conditions are applied. Steady flow through the network is then calculated using a mixed analytical-numerical technique. In each fracture, analytic equations for flow into or out of each node as a function of the average head at each node are developed. The equations are based on image theory and the assumption that each node is a source (or sink) of uniform strength. A set of mass balance equations is constructed which equate flow into a node from one of its associated fractures to flow out of the node into the other associated fracture. These equations are solved for the average head at each node, and flux between fractures can then be calculated by substituting the average head values back into the analytical equations. The model has been successfully checked against analytical results for several cases of two and three intersecting fractures. The authors plan to use these techniques to measure the permeability of fracture networks.

26014 **(LBL—19516) Models for calculation fluid flow in randomly generated three-dimensional networks of disc-shaped fractures: Users' manuals and listings for FMG3D, DISCEL, and DIMES.** Gilmour, H.M.P.; Billaux, D.; Long, J.C.S. (Lawrence Berkeley Lab., CA (USA)). Oct 1986. Contract AC03-76SF00098. 212p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87007911.

The purpose of this report is to provide the user with sufficient information to run the three programs FDG3D, DISCEL and DIMES. A previous report explained the theory and design of the programs (Models for Calculating Fluid Flow in Randomly Generated Three-Dimensional Networks of Disc-Shaped Fractures). Using the two reports, a thorough understanding of the codes is possible. This report should familiarize the user with program options and modes of operation, input variables, input and output files, and program warning and error stops. In addition, information not strictly needed to run the programs, but useful in understanding the internal structure and flow is provided in appendices. The appendices cover program variables and arrays, subroutines outlines, a short description of each subroutine, and finally listings of the codes. The additional information on FMG3D, DISCEL, and DIMES is in Appendices A, C and E respectively, and the listings are in Appendices B, D, and F. The codes are written in FORTRAN-77 for use on VAX computers. Large arrays are dimensioned by constants set in "parameter" statements. An "include" statement is used to insert an overall maximum dimensioning parameter statement in each main program and appropriate subroutine. For each program, the allowable problem size, controlled by the maximum number of fractures, nodes, etc., can be changed simply by editing the included parameter statement. Common blocks are also inserted in the code by include statements. Preceding each FORTRAN listing is a list of the files, maximum dimensions and common blocks, that are included by the programs.

26015 **(SAND—86-2382C) In situ stresses in low permeability, nonmarine rocks.** Warpinski, N.R.; Teufel, L.W. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 35p. (CONF-870529—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87006896.

From Society of Petroleum Engineers meeting on low permeability reservoirs; Denver, CO, USA (18 May 1987).

In situ stress measurements have been performed over a 2500-ft (760-m) interval in the nonmarine section of the Cretaceous Mesaverde in the Piceance basin in Colorado. These measurements include 27 hydraulic fracture measurements of the minimum in situ stress and 22 anelastic strain recovery (ASR) measurements. Stress data were obtained in sandstones, shales, mudstones, siltstones and coals and show the effect of lithology on the magnitudes of the stresses. Most tests in nonreservoir, clay-rich rocks had stress magnitudes near the lithostatic value, while reservoir rocks had considerably lower stress magnitudes. Stress orientations in these channel and meander belt sandstones were consistent throughout the section and showed no variation with channel direction. Where available, these results are compared with other techniques that give stress orientation and magnitude and consistent results are found.

26016 **(UCRL—95941) Inelastic properties of ice I/sub h/ at low temperatures and high pressures.** Kirby, S.H.; Durham, W.B.; Beeman, M.L.; Heard, H.C.; Daley, M.A. (Geological Survey, Menlo Park, CA (USA); Lawrence Livermore National Lab., CA (USA); Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science). Jan 1987. Contract W-7405-ENG-48. 8p. (CONF-8609269—1). NTIS, PC A02. File Number DE87007334.

From 7. symposium on the physics and chemistry of ice; Grenoble, France (1 Sep 1986).

The aim was to explore the rheological behavior of H_2O ices under conditions appropriate to the interiors of the icy satellites of the outer planets in order to give insight into their deformation. To this end, we have performed over 100 constant-strain-rate compression tests at pressures to 500 MPa and temperatures as low as 77 K. The effect of increasing confining pressure on stress-strain behavior and deformation mechanisms depends on the test temperature. At a strain rate of $3.5 \times 10^{-5}\ s^{-1}$, ice I/sub h/ fails catastrophically at temperatures below 165 K at all pressures tested (0.1 to 350 MPa). Failure strength increases sharply with increasing pressure. At $P >$ 30 MPa, ice I/sub h/ fails by a shear instability producing faults in the maximum shear stress orientation and failure strength typically is independent of pressure. We have also studied the frictional sliding characteristics of ice I/sub h/ by shortening cylindrical specimens sawn and ground at 45° to the cylindrical axis. We observed sudden (stick slip) frictional sliding with the maximum shear strength necessary to overcome static friction tau obeying the simple law tau (MPa) = 8.5 + 0.2 σ/sub n/ (MPa) where σ/sub n/ is the normal stress on the sliding surface. This law was determined over the range 17 $\leqq$ σ/sub n/ $\leqq$ 240 MPa and is insensitive to temperature and sliding rate over the range of conditions we explored. Stress-strain curves under ductile conditions typically display a linear quasi-elastic stage followed by macroscopic yield, strain softening and finally a flat steady state flow. Optical study of thin sections of samples taken to various strains shows that macroscopic yield corresponds to the first optical evidence of internal plastic deformation, that nucleation and rapid growth of new grains accompanies strain softening and that steady-state flow corresponds to the attainment of a steady-state recrystallization structure.

5804 Geochemistry

REFER ALSO TO CITATION(S) 24663, 25422

26017 **Origin of paleochemical signature in North Pacific pelagic clays: partitioning experiments.** Leinen, M. (Univ. of Rhode Island, Narragansett). *Geochimica et Cosmochimica Acta;* **51**: No. 2, 305-319(Feb 1987). Contract AS02-76DP02689.

Three techniques for partitioning sediment chemical composition into source end-members, normative partitioning, multivariate Q-mode factor analysis, and linear programming were used to determine the origin of chemical variation in a pelagic clay core, LL44-GPC3, from the central North Pacific. All partitioning models indicated that the downcore elemental distributions reflect the changing relative influence of detrital, hydrothermal, and hydrogenous sediment components. Two models suggested that biogenic sediment components influenced the sediment as well. The down core distributions of these end-members were very similar in all models, although the chemical compositions of the end-members varied slightly. There was no indication that the compositions of the end-members changed significantly over the 70 m.y. of clay sedimentation represented in the core. The changes in relative importance of the end-members downcore cannot be explained solely by changes in the position of the core site along its backtrack path and therefore suggest that there have been changes in the relative importance of difference sediment sources to the North Pacific during the Cenozoic.

5805 Oceanography

REFER ALSO TO CITATION(S) 25430

26018 **(DOE/ER/60351—2) Nearshore transport processes affecting the dilution and fate of energy-related contaminants: Progress report, 1 December 1985-30 November 1986.** Blanton, J.O. (Skidaway Inst. of Oceanography, Savannah, GA (USA)). Jan 1987. Contract FG09-85ER60351. 105p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006734.

Progress reported here relates to: advective processes in coastal frontal zones; instabilities in frontal zones; interactions of shelf circulation with Gulf Stream; evidence for continental shelf waves; and field experiment in autumn, 1986.

26019 (SAND—86-2137) Numerical simulation of hole-closure experiments on a large centrifuge. McTigue, D.F.; Sutherland, H.J.; Dawson, P.R. (Sandia National Labs., Albuquerque, NM (USA); Cornell Univ., Ithaca, NY (USA). Sibley School of Mechanical and Aerospace Engineering). Apr 1987. Contract AC04-76DP00789. 32p. NTIS MF A01; 2; GPO Dep. File Number DE87007822.

The creep closure of a slot in water-saturated clay has been simulated numerically with the finite-element computer code NEPTUNE. The calculations model scaled experiments performed on the Sandia 25-foot centrifuge at 90 g. The material model used represents the clay matrix as a linearly viscous fluid, the volumetric deformation rate of which depends upon the "effective" mean normal stress. Simulations have been run for a range of material properties and a variety of possible boundary conditions. The calculations indicate that the deformation is dominated by shearing, while volumetric creep is relatively unimportant, i.e., the characteristic time for the deformation is short in comparison to that for the flow of interstitial fluid. Velocities of the order observed in the centrifuge experiments (~ 1 m/s) are calculated for a shear viscosity of 10^3 Pa . s, which is of a magnitude consistent with values reported in the literature. The overall kinematics of the experimental flow field is reproduced satisfactorily for reasonable boundary conditions on the material in the neighborhood of the hole. The calculations demonstrate that the formulation implemented in the NEPTUNE computer code is able to predict certain observable aspects of the creep deformation of water-saturated clay. Thus, the comparison between experimental observations and computational results provides partial validation of the code.

64 PHYSICS I

6401 Astrophysics And Cosmology

REFER ALSO TO CITATION(S) 25727, 26078, 26155, 26179, 26209, 26209

26020 (AD-A—176227/7/XAB) Coronal activity at radio wavelengths. Kundu, M.R. (Maryland Univ., College Park (USA)). 1986. 7p. (SCIENTIFIC—2). NTIS, PC A02/MF A01.

Published in Highlights of Astronomy, 725-730(1986).

The multifrequency radioheliograph of the Clark Lake Radio Observatory is described. Its use for studies of large-scale structures of the corona at long radio wavelengths is discussed. It is shown that features corresponding to coronal streamers and coronal holes are readily apparent in the Clark Lake maps. Results are also presented on studies of microbursts at meter-decameter wavelengths.

26021 (AD-A—176284/8/XAB) Solar microbursts at meter-decameter wavelengths. Kundu, M.R.; Gergely, T.E.; Szabo, A.; Loiacono, R.; White, S.M. (Maryland Univ., College Park (USA)). 1 Sep 1986. 8p. (SCIENTIFIC—3). NTIS, PC A02/MF A01.

Published in Astrophysical J., Vol. 308, 436-442(1 Sep 1986).

Microbursts are low-brightness temperature bursts observed by the Clark Lake radioheliograph. The bursts occur several times per hour during quiet Sun periods and are seen at the observing frequencies from 30 to 70 MHz. They are stationary at a given frequency, have short rise times, and durations of 2-10 s. Observations of the bursts are presented and given an interpretation in terms of plasma emmission. The burst properties suggest that they are weak type III bursts. The observations imply that energy releases on the Sun continue to be impulsive, with nonthermal electron distributions, for small releases of energy. The relation of the bursts to type III bursts and hard X-ray bursts are discussed.

26022 (N—87-12406) Variability studies of 3C 371. Final report, 1 April 1985-30 September 1986. Worrall, D.M. (Smithsonian Astrophysical Observatory, Cambridge, MA (USA)). Oct 1986. 4p. (NASA-CR—179772; NAS—1.26:179772). NTIS, PC A02/MF A01.

The compact extragalactic radio source, 3C 371, was observed with the x-ray detectors of the EXOSAT satellite for 19.5 hours in 2 observing periods separated by 18 days. This resulted in the discovery of x-ray variability of the source on time scales between 8 hours and about 25 minutes and the confirmation of earlier reports of variability on longer time scales. The short time scale variability agrees remarkably well with earlier predictions based on fitting multifrequency data from the source to a relativistically beamed inhomogeneous synchrotron self-Compton (SSC) jet model. This SSC model is frequently applied to BL Lac objects and related sources, such as 3C 371. However, the number of free parameters in model fits tends to be large, and so independent support such as from this work is important. The x-ray spectral results for 3C 371 also may provide qualitative support for the SSC model in that the spectrum probably consists of two components, with the steeper one at low photon energies. In terms of the model, the low-energy spectrum would be dominated by synchrotron emission extending down to radio energies, whereas the higher energy x-rays would be dominated by Compton radiation.

26023 (N—87-12407) Reports of planetary astronomy, 1985. (National Aeronautics and Space Administration, Washington, DC (USA)). Sep 1986. 217p. (NASA-TM—89189; NAS—1.15:89189). NTIS, PC A10/MF A01.

This is a compilation of abstracts of reports from Principal Investigators funded through NASA's Planetary Astronomy Program, Office of Space Science and Applications. The purpose is to provide a document which succinctly summarizes work conducted in this program for 1985. Each report contains a brief statement on the strategy of investigation and lists significant accomplishments within the area of the author's funded grant or contract, plans for future work, and publications.

26024 (N—87-12508) Antarctic meteorite newsletter, volume 9, number 1. (National Aeronautics and Space Administration, Houston, TX (USA). Lyndon B. Johnson Space Center). Feb 1986. 29p. (NASA-TM—89230; NAS—1.15:89230). NTIS, PC A03/MF A01.

Topics addressed include: petrographic descriptions of new meteorites; homogeneous powders of Antarctic meteorites; policy on consortium studies, and saw-cut surfaces of Shergottite EETA79001.

26025 (N—87-12510) Chromospheric activity of cool giant stars. Final report. Steiman-Cameron, T.Y. (Carnegie Institution of Washington, DC (USA)). Nov 1986. 9p. (NASA-CR—177184; NAS—1.26:177184). NTIS, PC A02/MF A01.

During the seventh year of IUE twenty-six spectra of seventeen cool giant stars ranging in spectral type from K3 thru M6 were obtained. Together with spectra of fifteen stars observed during the sixth year of IUE, these low-resolution spectra have been used to: (1) examine chromospheric activity in the program stars and late type giants in general, and (2) evaluate the extent to which nonradiative heating affects the upper levels of cool giant photospheres. The stars observed in this study all have well determined TiO band strengths, angular diameters (determined from lunar occulations), bolometric fluxes, and effective temperatures. Chromospheric activity can therefore be related to effective temperatures providing a clearer picture of activity among cool giant stars than previously available. The stars observed are listed.

26026 (N—87-12519) Extended atmospheres of outer planet satellites and comets. Annual report, 1 August 1985-31 July 1986. Smyth, W.H.; Combi, M.R. (Atmospheric and Environmental Research, Inc., Cambridge, MA (USA)). Sep 1986. 28p. (NASA-CR—176888; NAS—1.26:176888). NTIS, PC A03/MF A01.

An analysis of the extended atmospheres of outer planet satellites and comets is made. Primary emphasis is placed on cometary atmospheres because of the return of Comet P/Halley. As part of a collaborative effort with A.I.F. Stewart, observations of the hydrogen coma of Comet P/Giacobini-Zinner obtained from the Pioneer Venus Orbiter ultraviolet spectrometer (PVOUVS) were successfully analyzed at AER and are reported. In addition, significant pre-modeling and post-modeling activities to support and analyze the PVOUVS observations of Comet P/Halley successfully acquired in late 1985 and early 1986 are also discussed. Progress in model preparation for third-year analysis of the Voyager UVS Lyman-alpha brightness distribution emitted by hydrogen atoms in the Saturn system is also summarized.

26027 **(N—87-12520) Pioneer 10 and 11 (Jupiter and Saturn) magnetic field experiments. Final report.** Jones, D.E. (Brigham Young Univ., Provo, UT (USA)). Oct 1986. 133p. (NASA-CR—179856; NAS—1.26:179856). NTIS, PC A07/MF A01.

Magnet field data obtained by the vector helium magnetometer (VHM) during the encounters of Jupiter (Pioneer 10 and 11) and Saturn (Pioneer 11) was analyzed and interpreted. The puzzling characteristics of the Jovian and Saturnian magnetospheric magnetic fields were studied. An apparent substorm (including thinning of the dayside tail current sheet) was observed at Jupiter, as well as evidence suggesting that at the magnetopause the cusp is at an abnormally low latitude. The characteristics of Saturn's ring current as observed by Pioneer 11 were dramatically different from those suggested by the Voyager observations. Most importantly, very strong perturbations in the azimuthal ring current magnetic field suggest that the plane of the ring was not in the dipole equatorial plane, being tilted 5 to 10 deg. relative to the dipole and undergoing significant changes during the encounter. When these changing currents were corrected for, an improved planetary field determination was obtained. In addition, the ring and azimuthal currents at Saturn displayed significantly different time dependences.

26028 **(N—87-12522) Simultaneous solar maximum mission (SMM) and very large array observations of solar active regions. Annual report, 1 September 1985-30 October 1986.** Lang, K.R. (Tufts Univ., Medford, MA (USA)). Oct 1986. 158p. (NASA-CR—177187; NAS—1.26:177187). NTIS, PC A08/MF A01.

The research deals mainly with Very Large Array and Solar Maximum Mission observations of the ubiquitous coronal loops that dominate the structure of the low corona. As illustrated, the observations of thermal cyclotron lines at microwave wavelengths provide a powerful new method of accurately specifying the coronal magnetic field strength. Processes are delineated that trigger solar eruptions from coronal loops, including preburst heating and the magnetic interaction of coronal loops. Evidence for coherent burst mechanisms is provided for both the Sun and nearby stars, while other observations suggest the presence of currents that may amplify the coronal magnetic field to unexpectedly high levels. The existence is reported of a new class of compact, variable moving sources in regions of apparently weak photospheric field.

26029 **(N—87-12523) Solar flare x-ray polarimetry. Final scientific report, 1 April 1984-30 September 1986.** Chanan, G.A.; Novick, R. (California Univ., Irvine (USA)). Oct 1986. 36p. (NASA-CR—179899; NAS—1.26:179899). NTIS, PC A03/MF A01.

The motivation for high quality solar flare x-ray polarization measurements are discussed in general. The design of the proposed instrument is described and then the sensitivity and energy response are discussed. The laboratory work which demonstrates that the earlier lithium contamination problem was solved is described.

26030 **(N—87-13363) Infrared reflection nebulae in Orion molecular cloud 2.** Pendleton, Y.; Werner, M.W.; Capps, R.; Lester, D. (National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center). Jun 1986. 46p. (NASA-TM—88259; A—86276; NAS—1.15:88259). NTIS, PC A03/MF A01.

New obervations of Orion Molecular Cloud-2 have been made from 1-100 microns using the NASA Infrared Telescope Facility and the Kuiper Airborne Observatory. An extensive program of polarimetry, photometry and spectrophotometry has shown that the extended emission regions associated with two of the previously known near infrared sources, IRS1 and IRS4, are infrared reflection nebulae, and that the compact sources IRS1 and IRS4 are the main luminosity sources in the cloud. The constraints from the far infrared observations and an analysis of the scattered light from the IRS1 nebula show that OMC-2/IRS1 can be characterized by L less than or equal to 500 Solar luminosities and T approx. 1000 K. The near infrared (1-5) micron albedo of the grains in the IRS1 nebula is greater than 0.08.

26031 **(N—87-13365) Observational study of ion-electron equilibration and of cloud evaporation in supernova remnants under the HEAO-2 guest investigator program. Final project report, 1 June 1985-30 September 1986.** Teske, R.G. (Michigan Univ., Ann Arbor (USA)). Sep 1986. 11p. (NASA-CR—179922; NAS—1.26:179922). NTIS, PC A02/MF A01.

Observations of three selected supernovae remnants (Cygnus Loop, IC 443, and Puppis A) were made in the forbidden coronal iron lines (Fe X) lambda 6374 and (Fe XIV) lambda 5303. The resulting data was compared quantitatively with Einstein images of the same objects, and an attempt was made to determine (a) the process by which ion and electron energies are equilibrated behind the shock front in the ISM and (b) whether cloud evaporation occurs within the hot remnant interiors. Spatially-resolved x-ray emission were modeled for Sedov-Taylor blast wave models of supernovae remnants (SNR) under conditions of non-equlibrium ionization. The computations are intended to provide results that can be directly compared with Einstein high resolution image (HRI) and imaging proportional counter (IPS) data. The computer program for predicting the spatial distribution of HRI and IPS counting rates was completed, and final testing of it had begun.

26032 **(N—87-13366) High energy neutrino absorption and its effects on stars in close x-ray binaries.** Gaisser, T.K.; Stecker, F.W. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Jul 1986. 21p. (NASA-TM—89269; NAS—1.15:89269). NTIS, PC A02/MF A01.

The physics and astrophysics of high energy neutrino production and interactions in close x-ray binary systems are studied. These studies were stimulated by recent observations of ultrahigh energy gamma rays and possibly other ultrahigh energy particles coming from the directions of Cygnus X-3 and other binary systems and possessing the periodicity characteristics of these systems. Systems in which a compact object, such as a neutron star, is a strong source of high energy particles which, in turn, produce photons, neutronos and other secondary particles by interactions in the atmosphere of the companion star were considered. The highest energy neutrinos are absorbed deep in the companion and the associated energy deposition may be large enough to effect its structure or lead to its ultimate disruption. This neutrino heating was evaluated, starting with a detailed numerical calculation of the hadronic cascade induced in the atmosphere of the companion star. For some theoretical models, the resulting energy deposition from neutrino absorption may be so great as to disrupt the companion star over an astronomically small timescale of the order of 10,000 years. Even if the energy deposition is smaller, it may still be high enough to alter the system substantially, perhaps leading to quenching of high energy signals from the source. Given the cosmic ray luminosities required to produce the observed gamma rays from cygnus X-3 and LMX X-4, such a situation may occur in these sources.

26033 **(N—87-15931) EX56a study of extended X-ray emission around isolated galaxies EX56b identification and spectra of bright X-ray sources at high galactic latitude. Final report, 1 April 1985-30 November 1986.** Schwartz, D. A. (Smithsonian Astrophysical Observatory, Cambridge, MA (USA)). Jan 1987. 5p. (NASA-CR—180099; NAS—1.26:180099). NTIS, PC A02/MF A01.

The EXOSAT observations confirmed the identification and extended nature of PKS 2345-35. It gave a good 2 to 10 keV x-ray spectrum and a detailed spatial profile indicating asymmetry of the structure. In the high galactic latitidue investigation, the BL Lac object identified with the HEAO-1 source 1430+423 was detected, and the first x-ray spectrum was obtained. Several simulataneous observations of H0323+022 were obtained over a broad range of electromagnetic spectrum. Studies of luminous active galactic nuclei have given significant information on the spectrum of the quasar PKS 0558-504. In a study of Southern sky cataclysmic variables, the EXOSAT was used to determine the x-ray spectrum and search for periodicities in two objects. Studies of complete identifications have revealed that x-ray sources in two high galactic latitude fields are stars, and therefore are to be excluded from the Piccinotti extragalactic sample. Only one Piccinotti source remains to be identified.

26034 (N—87-16720) Occultation studies of the Solar system. Semiannual status report, 1 July-31 December 1986. Millis, R. L. (Lowell Observatory, Flagstaff, AZ (USA). Planetary Research Center). Feb 1987. 4p. (NASA-CR—180143; NAS—1.26:180143; SASR—13). NTIS, PC A02/MF A01.

The planetary occultation program began at Lowell Observatory in 1973 with a worldwide campaign to observe mutual occultations and eclipses of the Galilean Satellites. Then the temperature profile of the Martian atmosphere was measured from data taken during the occultation of epsilon Geminorum, the Rings of Uranus were discovered as they occulted SAO 158687, and the dimensions of Pallas were measured when that minor planet occulted SAO 85009. In 1979 the present grant was initiated, providing funds for portable photometric instrumentation used to observe occultations by asteroids as well as by Uranus and Neptune. Software for predicting occultations of catalog stars by asteroids, planets, and comets was written in 1983. Lowell currently provides most of the available predictions for asteroid occultations. Realizing in 1983 that the lack of a high-quality astrometric telescope dedicated to occultation work was limiting progress, an 18-inch, F/8 lens was acquired and adapted to an existing mounting at Lowell. Although acquisition of the lens and implementation of the new telescope has been accomplished primarily with non-grant funds, the instrument makes a major contribution to occultation research.

26035 (N—87-16742, pp vp) **How are quasars fueled? Simulating interstellar gas in tidally disturbed galaxies.** Byrd, G. G. Nov 1986. NTIS, PC A99/MF E04. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—).

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

Whether gravitational tides from companions trigger global instabilities in spiral galaxy disks and thus rapid flows of gas into the nucleus to fuel activity is investigated. An n-body computer program is used to simulate the disk of the spiral galaxy within a much more stable, high-velocity dispersion spherical halo. Under sufficient perturbation, the disk undergoes violent distortions due to the disturber and its self-gravitation. The tidal action of companions was simulated and the tidal strengths at which the instabilities appear to match those of the observed companions of Seyferts and quasars was shown. With the additional modifications planned, the gas flow will be more realistically simulated to compare with observations (e.g., colors, velocity fields) of active galaxies.

26036 (N—87-16742, pp vp) **Some atmospheric scattering considerations relevant to BATSE: a model calculation.** Young, J.H. Nov 1986. NTIS, PC A99/MF E04. (NASA-CR—178966; NAS—1.26:178966; CONF-8605246—).

From NASA/ASEE summer faculty fellowship program; Huntsville, AL, USA (27 May 1986).

The orbiting Burst and Transient Source Experiement (BATSE) will locate gamma ray burst sources by analysis of the relative numbers of photons coming directly from a source and entering its prescribed array of detectors. In order to accurately locate burst sources it is thus necessary to identify and correct for any counts contributed by events other than direct entry by a mainstream photon. An effort is described which estimates the photon numbers which might be scattered into the BATSE detectors from interactions with the Earth atmosphere. A model was developed which yielded analytical expressions for single-scatter photon contributions in terms of source and satellite locations.

26037 (PB—87-143319/XAB) Observations of the solar chromosphere in Kunming. Zhou, Y.; Li, Q. (Yunnan Observatory, Kunming (China)). 1986. 10p. NTIS, PC PC E03/MF E01.

This paper gives an account of the process of the solar total eclipse of February 16, 1980 in the chromospheric layers observed in Kunming, China. It also provides the moments of occultations of various active objects (including sunspots, flocculi, filaments and prominences) by the shadow of the Moon. They are important clues for the analyses of radio-astronomical, ionospheric, and various optical observations of the solar eclipse.

26038 (PB—87-143335/XAB) Total light flux and colour of solar corona. Hao, Y. (Beijing Normal Univ., BJ (China)). 1986. 10p. NTIS, PC PC E03/MF E01.

Measurements were made of the light flux and color of the corona in 1.03-6.0 solar radii with a multiple-band electrophotometer. The effective wavelengths of the instrument are 450, 555, 650, and 940 (mu). In one of them, i.e., the 555 (mu) band, the spectral response defines a system that is in close agreement with the spectral response of the human eye. The results of the measurements are as follows: (1) The total light flux of the corona Lc is equal to 1.23 x 10^{-7} L(Solar); (2) In 555, 650, and 940 (mu) bands, there is no color difference between the corona and the photosphere.

26039 (PNL-SA—14385) Experimental bounds on $\beta\beta$-decay, cold dark matter and solar axions with an ultralow background Ge detector. Avignone, F.T. III; Ahlen, S.P.; Brodzinski, R.L.; Dimopolous, S.; Drukier, A.K.; Gelmini, G.; Lynn, B.W.; Miley, H.S.; Reeves, J.H.; Spergel, D.N. (South Carolina Univ., Columbia (USA); Boston Univ., MA (USA); Pacific Northwest Lab., Richland, WA (USA); Stanford Univ., CA (USA); Harvard-Smithsonian Center for Astrophysics, Cambridge, MA (USA); Harvard Univ., Cambridge, MA (USA)). 8 Oct 1986. Contract AC03-76SF00515;AC06-76RL01830. 21p. (CONF-8605182—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87002065.

From 7. Vanderbilt high energy physics conference; Nashville, TN, USA (15 May 1986).

The PNL/USC ultralow background prototype Ge detector in the Homestake goldmine is being applied to searches for 0 nu $\beta\beta$-decay, dark matter candidates and solar axions. An upper bound of 2.2 eV has been placed on the Majorana mass of the electron neutrino. The low energy data exclude particles with spin independent Z^0 exchange interactions having masses between 20 GeV and 5 TeV as significant contributors to the cold dark matter of the halo of our galaxy. The existence of stable Dirac neutrinos more massive than 20 GeV is also excluded except for a narrow region around the Z^0 resonance. Finally, Dine-Fischler-Srednicki (DFS) axion models with F/2x'/sub e/ $\leqq$ 0.5 x 10^7 GeV are ruled out by the maximum count rate attributable to solar axions. 36 refs., 11 figs.

26040 Search for a substance-dependent force with a new differential accelerometer. Thieberger, P. (Brookhaven National Laboratory, Upton, New York 11973). *Physical Review Letters;* **58**: No. 11, 1066-1069(16 Mar 1987). Contract AC02-76CH00016.

A well-balanced hollow copper sphere freely floating and almost totally submerged in water is observed to move toward the nearby edge of a cliff. This observation is consistent with a substance-dependent, medium-range force postulated in a recent reanalysis of the Eoetvoes experiment. Further measurements with different elements and geometries will be required to establish definitely the existence, source, and description of such a new force.

26041 Search for an intermediate-range interaction. Stubbs, C.W.; Adelberger, E.G.; Raab, F.J.; Gundlach, J.H.; Heckel, B.R.; McMurry, K.D.; Swanson, H.E.; Watanabe, R. (Physics Department, University of Washington, Seattle, Washington 98195). *Physical Review Letters;* **58**: No. 11, 1070-1073(16 Mar 1987).

We have placed a torsion balance (containing two Be and two Cu test bodies) on a hillside to search for intermediate-range forces that couple to baryon number. Our results constrain (at 1σ) the strength of such an interaction to be chemical bondalpha-tildechemical bond$\leqq$1 x 10/sup -4/ for ranges $250 \leqq \lambda \leqq 1400$ m and chemical bondalpha-tildechemical bond$\leqq$1 x 10/sup -3/ for ranges $30 < \lambda < 250$ m.

26042 **On the noncoplanarity of the magnetic field within a fast collisionless shock.** Thomsen, M.F.; Gosling, J.T.; Bame, S.J.; Quest, K.B.; Winske, D.; Livesey, W.A.; Russell, C.T. (Los Alamos National Laboratory, Los Alamos, New Mexico). *Journal of Geophysical Research;* **92**: No. A3, 2305-2314(1 Mar 1987).

Within the magnetic ramp of fast collisionless plasma shocks observed with spacecraft instruments and simulated numerically, the magnetic field undergoes an excursion out of the plane of coplanarity (the plane determined by the upstream magnetic field and the shock normal). This rotation is consistently in the direction such that the electrostatic potential jump across the shock, as measured in the de Hoffman-Teller frame of reference (HTF), is — 2—6 times smaller than the electrostatic potential jump measured in the normal incidence frame. The preferred direction is consistent with a basic whistler mode transition between the upstream and downstream orientations. The potential jump in the HTF is considerably smaller than the change in bulk flow energy across the shock, confirming the recent suggestion that magnetic forces contribute importantly to the slowing of the plasma in that frame. A further consequence is that suprathermal particles leaking back into the upstream region across the shock do not gain much energy from the cross-shock electric field. copyrightAmerican Geophysical Union 1987

26043 **Explosive coalescence of magnetic islands.** Tajima, T.; Sakai, J.I. (Dept. of Physics and Institute for Fusion Studies, Univ. of Texas at Austin, Austin, TX 78712-1081). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 929-933(Dec 1986).

An explosive reconnection process associated with nonlinear evolution of the coalescence instability is found through studies of particle and magnetohydrodynamic (MHD) simulations. The explosive coalescence is a self-similar process of magnetic collapse, in which the magnetic and electrostatic energies and temperatures explode toward the explosion time t/sub 0/ as (t/sub 0/ - t)/sup -8/3/ , (t/sub 0/ - t)/sup -4/, and (t/sub 0/ - t)/sup -8/3/, respectively. Ensuing amplitude oscillations in these quantities are identified by deriving an equation of motion for the scale factor in the Sagdeev potential. A possible application to the impulsive phase of solar flares is offered.

26044 **Evolution of the plasma universe: I. Double radio galaxies, quasars, and extragalactic jets.** Peratt, A.L. (Los Alamos National Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 639-660(Dec 1986).

Cosmic plasma physics and our concept of the universe is in a state of rapid revision. This change started with in-situ measurements of plasmas in Earth's ionosphere, cometary atmospheres, and planetary magnetospheres; the translation of knowledge from laboratory experiments to astrophysical phenomena; discoveries of helical and filamentary plasma structures in the Galaxy and double radio sources; and the particle simulation of plasmas not accessible to in-situ measurement. Because of these, Birkeland (field-aligned) currents, double layers, and magnetic-field-aligned electric fields are now known to be far more important to the evolution of space plasma, including the acceleration of charged particles to high energies, than previously thought. This paper and its sequel investigate the observational evidence for a plasma universe threaded by Birkeland currents or filaments. This model of the universe was inspired by the advent of three-dimensional fully electromagnetic particle simulations and their application to the study of laboratory z pinches. This study resulted in totally unexpected phenomena in the data post-processed from the simulation particle, field, and history dumps. In particular, when the simulation parameters were scaled to galactic dimensions, the interaction between pinched filaments led to synchrotron radiation whose emission properties were found to share the following characteristics with double radio galaxies and quasars: power magnitude, isophotal morphology, spectra, brightness along source, polarization, and jets. The evolution of these pinched synchrotron emitting plasmas to elliptical, peculiar, and spiral galaxies by continuing the simulation run is addressed in a sequel paper.

26045 **Evolution of the plasma universe: II. The formation of systems of galaxies.** Peratt, A.L. (Los Alamos National Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 763-778(Dec 1986).

The model of the plasma universe, inspired by totally unexpected phenomena observed with the advent and application of fully three-dimensional electromagnetic particle-in-cell simulations to filamentary plasmas, consists of studying the interaction between field-aligned current-conducting, galactic-dimensioned plasma sheets or filaments (Birkeland currents). In a preceding paper, the evolution of the interaction spanned some 10/sup 8/-10/sup 9/ years, where simulational analogs of synchrotron emitting double radio galaxies and quasars were discovered. This paper reports the evolution through the next 10/sup 9/-5 x 10/sup 9/ years. In particular, reconfiguration and compression of tenuous cosmic plasma due to the self-consistent magnetic fields from currents conducted through the filaments leads to the formation of elliptical, peculiar, and barred and normal spiral galaxies. The importance of the electromagnetic pinch in producing condense states and initiating gravitational collapse of dusty galactic plasma to stellisimals, then stars, is discussed. Simulation data are directly compared to galaxy morphology types, synchrotron flux, HI distributions, and fine detail structure in rotational velocity curves. These comparisons suggest that knowledge obtained from laboratory, simulation, and magnetospheric plasmas offers not only to enhance our understanding of the universe, but also to provide feedback information to laboratory plasma experiments from the unprecedented source of plasma data provided by the plasma universe.

26046 **IUE observations of phase-dependent variations in WN + O systems.** Koenigsberger, G.; Auer, L.H. (Pennsylvania State Univ., University Park). *Astrophysical Journal;* **297**: 255-265(1 Oct 1985).

IUE observations of six WN + O Wolf-Rayet (W-R) systems are reported. The periodic variations in five of the six systems are shown to result primarily from selective atmospheric eclipses of the O star continuum by the W-R wind. An optical depth distribution of the form tau proportional r^{-1} is suggested for $r \geqq 14$ R radius of sun. The presence of the N IV ionization stage out to at least $\sim$60 R radius of the sun is consistent with the proposed constant ionization structure in WN winds (Willis). Phase-dependent variations in the C IV 1550 absorption components in V444 Cyg, HD 90657, and HD 211853 are interpreted as wind-wind collision effects. 41 references, 4 figures, 4 tables.

26047 **Cosmology and particle physics.** Turner, M.S. (Fermi National Accelerator Center, Batavia, IL). pp 153-233 of Techniques and concepts of high-energy physics III. Ferbel, T. New York, NY; Plenum Press (1985). (CONF-8408160—).

From NATO advanced study institute on techniques and concepts of high energy physics; St. Croix, VI, USA (2 Aug 1984).

The author reviews the standard cosmology, focusing on primordial nucleosynthesis, and discusses how the standard cosmology has been used to place constraints on the properties of various particles. Baryogenesis is examined in which the B, C, CP violating interactions in GUTs provide a dynamical explanation for the predominance of matter over antimatter and the present baryon-to-baryon ratio. Monoposes, cosmology and astrophysics are reviewed. The author also discusses supersymmetry/supergravity and cosmology, superstrings and cosmology in extra dimensions, and axions, astrophics, and cosmology.

26048 **Upstream suprathermal ions.** Thomsen, M.F. (Los Alamos National Lab., NM). pp 253-270 of Collisionless shocks in the heliosphere: reviews of current research. Washington, DC; American Geophysical Union (1985).

The nature of the various populations of suprathermal ions observed in association with collisionless plasma shocks in space is reviewed. Particular emphasis is given to the ion foreshock region upstream of the earth's bow shock, although observations upstream of interplanetary shocks and of other planetary bow shocks are also addressed. Some of the properties of the low-frequency, hydromagnetic waves associated with the suprathermal ion populations are also reviewed. The present understanding of the probable origins of the various populations is assessed. 81 references, 8 figures, 1 table.

26049 Comparison of the X-ray observations of the AM Herculis objects to theory. Imamura, J.N. (Los Alamos National Lab., NM). *Astrophysical Journal;* **285**: 223-231(1 Oct 1984).

The authors reexamine the X-ray observations of the original AM Her objects (AM Her, VV Pup, EF Eri, and AN UMa). The authors work differs from that carried out previously in that the authors compare the observed X-ray spectral properties to theoretical models calculated using a dipolar accretion geometry rather than a spherically symmetric one, and the authors compare the observed X-ray light curves to theoretical light curves calculated assuming that the X-ray sources are cataclysmic variable-like binaries which contain a strongly magnetic white dwarf. The added constraints offered by the light curve properties restrict the possible kinds of X-ray emission scenarios in some cases. For instance, the authors find that the X-ray observations of AM Her can be self-consistently explained by accretion powered radiative shock models. Further, the observations cannot be self-consistently explained by conduction dominated models as has been suggested by previous workers. 45 references, 8 figures.

26050 Discovery of a 176 day period in 4U 1820-30. Priedhorsky, W.; Terrell, J. (Los Alamos National Lab., NM). *Astrophysical Journal;* **284**: L17-L20(1 Sep 1984).

Long-term X-ray observations of the X-ray burster 4U 1820-30 (in NGC 6624) reveal a significant 176.4 +/- 1.3 day period. These data were obtained by a 3-12 keV detector on the Vela 5B satellite during the years 1969-1976. The X-ray flux varies by a factor of 2 over the cycle; the light curve, which has a sawtooth shape with fast rise and slow decline, is quite similar to the 199 day light curve of the burster 4U 1915 - 05. These long-period variations may be intrinsic luminosity changes, perhaps similar to the quasi-periodic outbursts of dwarf novae, or aspect-dependent effects, such as periodic obscuration by a precessing accretion disk. 30 references, 3 figures.

26051 Discrepancy in the CNO opacity bump resolved. Carson, T.R.; Huebner, W.F.; Magee, N.H. Jr.; Merts, A.L. (Los Alamos National Lab., NM). *Astrophysical Journal;* **283**: 466-468(1 Aug 1984).

The discrepancy between the Los Alamos and the Carson opacities for mixtures containing metals at low densities around a temperature of 10^6 K (the CNO bump) has been investigated and resolved. The bump in the Carson opacities arises from a misapplied correction to the atomic level occupancies. Results from a modified Carson opacity program now show much closer agreement with the Los Alamos opacities. There is no evidence for a CNO bump. 14 references, 2 tables.

26052 Extinction of species by periodic comet showers. Davis, M.; Hut, P.; Muller, R.A. (Univ. of California, Berkeley). *Nature (London);* **308**: No. 5961, 715-717(19 Apr 1984). Contract AC03-76SF00098.

A 26-Myr periodicity has recently been seen in the fossil record of extinction in the geological past. At least two of these extinctions are known to be associated with the impact on the Earth of a comet or asteroid with a diameter of a few kilometers. The authors propose that the periodic events are triggered by an unseen companion to the Sun, travelling in a moderately eccentric orbit, which at its closest approach (perihelion) passes through the Oort cloud of comets which surrounds the Sun. During each passage this unseen solar companion perturbs the orbits of these comets, sending a large number of them (over 1 x 10^9) into paths which reach the inner Solar System. Several of these hit the Earth, on average, in the following million years. At present the unseen companion should be approximately at its maximum distance from the Sun, ~2.4 light yr, and it will present no danger to the Earth until approximately AD 15,000,000. 25 references.

26053 Observations of quasi-coherent soft X-ray oscillations in U geminorum and SS Cygni. Cordova, F.A.; Chester, T.J.; Mason, K.O.; Kahn, S.M.; Garmire, G.P. (Los Alamos National Lab., NM). *Astrophysical Journal;* **278**: 739-753(15 Mar 1984).

Soft X-ray pulsations (0.1-0.5 keV) have been detected for the first time from U Geminorum and for the second time from SS Cygni using the HEAO 1 satellite. Both dwarf novae were on the declining phase of an optical outburst. The average amplitudes of the pulses are 15% for U Gem and 18% for SS Cyg. The pulsations are quasi-coherent in character. If the authors define P/sub c/ to be the centroid of the period distribution and P_1 to be the standard deviation of the pulsation period then during the U Gem observation P/sub c/ = 27 s and P_1 = 6 s, while during the SS Cyg observation P/sub c/ = 10.7 s and P_1 = 1.8 s. In a previous X-ray observation of SS Cyg, and oscillation with P/sub c/ = 8.8 s and P_1 = 0.4 s was detected, illustrating that significant changes in period and coherence may occur. A blackbody spectral fit to the U Gem data yields best fit parameters of kT ~ 25 eV, N/sub H/ $\leqq$ 5 x 10^{18} cm^{-2}, and a 0.13-0.48 keV X-ray flux at the Earth of 3 x 10^{-10} ergs cm^{-2} s^{-1}. From pulse phase X-ray spectroscopic data, an upper limit of 50% may be set on any variation in temperature across U Gem's pulse. There is no evidence for an X-ray variation correlated with the optical eclipse of this 4.25 hr binary system. The average soft X-ray flux of SS Cyg during the second HEAO 1 pointing observation is f/sub x/ ~ 2 x 10^{-11} ergs cm^{-2} s^{-1}, one-half that detected in the first HEAO 1 soft X-ray pointing at this star. The authors review all the data on the X-ray and optical pulsations thus far detected in these two dwarf novae and discuss the observational constraints on various current models for the pulsations.

26054 Extension of the reconnection theory of two-ribbon solar flares. Kopp, R.A.; Poletto, G. (Los Alamos National Lab., NM). *Solar Physics;* **93**: 351-361(1984).

The magnetic reconnection theory for two-ribbon flares and flare loops hypothesizes that the gradual energy release during the decay phase is a direct result of dissipative relaxation of the open coronal magnetic configuration created by an eruptive prominence/coronal transient precursor. This scenario is here developed quantitatively to the point where a realistic comparison with observational data can be attempted. The major refinements are (i) to use an analytical description of the reconnecting field geometry specifically chosen to characterize the spatial scale of the active region where a flare occurs, and (ii) to take account of the fact that the volume occupied by X-ray-emitting plasma (hot loops) generally increases with time during the flare. As a test of the modified theory the authors have undertaken a new representation of the Skylab observations of the large two-ribbon flare of 29 July, 1973. It is hereby found that the simultaneous inclusion of the above two factors yields an excellent agreement between the theoretical prediction and observations of the time variation of flare-plasma energy density; such was not possible within the framework of previous work along these lines. The agreement extends, moreover, to rather early times in the flare history, where the short-comings of earlier studies became especially noticeable. This result constitutes strong evidence to support previous speculations that magnetic reconnection may provide the sole energy source throughout nearly the entire flare lifetime. 14 references, 5 figures.

26055 Cosmology and particle physics. Turner, M.S. (Fermi National Accelerator Lab., Batavia, IL). pp 355-432 of Quarks, leptons, and beyond. Fritzsch, H.; Peccei, R.D.; Saller, H. New York, NY; Plenum Press (1983). (CONF-8309201—).

From NATO advanced study institute on quarks, leptons and beyond; Muenich, F.R. Germany (5 Sep 1983).

This paper comprises the contents of four lectures in which the author illustrates the two-way nature of the interplay between the fields of cosmology and particle physics by focusing on several specifics: a review of the standard cosmology, concentrating on primordial nucleosynthesis; baryogenesis; monopoles; and the case in which a very early first-order phase transition associated with spontaneous symmetry breaking has the potential to explain some very fundamental cosmological facts.

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REFER ALSO TO CITATION(S) 26044, 26045

26056 **(AD-A—175774/9/XAB) Plasma flows near the neutral sheet of the magnetotail. Progress report for period ending 1986.** Huang, C.Y.; Frank, L.A.; Eastman, T.E. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). Jan 1986. 21p. (U.OF-IOWA—86-15). NTIS, PC A02/MF A01.

The Lepedea on board ISEE 1 was used to investigate the bulk-flow plasma in the neutral sheet region (defined as the area where BX approx = 0) of the magnetotail. For the majority of crossings there is no appreciable change in the macroscopic plasma parameters, i.e., the density, temperature, and velocity of the plasma remain constant through the neutral sheet. This is true even during active periods, when AE somewhat > 100nT. However, for a small number of crossings, all during disturbed times, large plasma-bulk velocities abs. val V > or = 300 km/s are observed. The velocity distributions during these events are qualitatively similar to those of the plasma-sheet boundary layer that is usually observed at higher latitudes. The acceleration mechanism that creates the plasma-sheet boundary layer extends to relatively small radial distances during these active periods. (Reprints).

26057 **(AD-A—176242/6/XAB) Interchange instability in high-latitude plasma blobs. Memorandum report.** Chaturvedi, P.K.; Huba, J.D. (Naval Research Lab., Washington, DC (USA)). 30 Dec 1986. 38p. (NRL-MR—5895). NTIS, PC A03/MF A01.

The stability of high-latitude plasma-density enhancements (blobs) is analyzed with regard to the interchange model (driven by a neutral wind or transverse electric field acting on the density gradient at the walls of the blobs). The effects arising from the finite parallel length of the blobs along the magnetic field lines are included in the analysis. Plasma regions of differing collisionalities, to which the blobs extend in altitude, are considered. It was found that the finite-parallel blob size results in a modest reduction in the growth rates of the small somewhat < 1 km) and intermediate (1-10 km) scale sizes, but severely reduces the growth rates, for the large scale sizes (> 10 kms) for the observed parallel blob lengths (approx. 300-600 kms). Further, it is found that the instability growth rates show a moderate reduction at higher altitudes (where ion-inertial effects may be dominant over the ion-neutral collisional effects). Thus, the E x B instability is considered a plausible candidate for the scintillation causing irregularities (1-10 kms) associated with the high-latitude blobs.

26058 **(N—87-16463) Plasmasphere and magnetosphere structure from ISEE-1 and DE-1. Progress report.** Olsen, R. C. (Alabama Univ., Huntsville (USA)). Jan 1987. 8p. (NASA-CR—180111; NAS—1.26:180111). NTIS, PC A02/MF A01.

The density structure of the plasmapause was investigated using the two satellites ISEE-1 and DE-2 to obtain complementary radial and latitudinal profiles. Data from the plasma wave receivers were to be used to obtain the total electron density, and from the ion mass spectrometers to determine thermal plasma morphology. Electron density profiles were obtained for 25 sets of orbits when the satellites were adjacent.

26059 **Hall effects on magnetic relaxation.** Turner, L. (Los Alamos National Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 849-857(Dec 1986).

A generalized vorticity is introduced whose self-linkage (the hybrid helicity) and flux are invariants of ideal incompressible magnetohydrodynamics (MHD) when the Hall term is included. A model of magnetofluid relaxation is constructed for Hall magnetohydrodynamics by assuming that the energy seeks the minimum value compatible with constrained values of magnetic helicity, hybrid helicity, axial magnetic flux, and fluid vorticity flux. As a result of the coupling of magnetic field to fluid vorticity in the generalized vorticity, it is found that the relaxed magnetic-field configuration need not be force free. The presence of a nonvanishing fluid vorticity is shown to be necessary for the existence of relaxed magnetic-field configurations that confine a finite plasma pressure. The study has potential relevance to the dynamics and morphology of space and cosmic plasmas, as well as to pressure confinement and current drive in fusion plasmas.

26060 **The Alpha effect: The connection between cyclonic events and current helicity.** Keinigs, R.; Gerwin, R.A. (Los Alamos National Lab., Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 858-861(Dec 1986).

In a magnetized plasma, resistive diffusion of large-scale magnetic fields can be suppressed or even overcome by a turbulently generated electromotive force. For a plasma in which the turbulence is homogeneous and isotropic this EMF is characterized by the ensemble average (δv x δb) = αB/sub 0/, where δv and δb represent the turbulent fields and B/sub 0/ defines the large-scale field. Determination of the statistical properties of the turbulence that are required to generate a finite alpha effect, as it has become known, is one of the central subjects of dynamo theory. Parker has shown that helical velocity fluctuations possessing a net amount of kinetic helicity are capable of dynamo action. These "cyclonic events" produce electromagnetic fluctuations characterized by their own statistical properties. Within the context of "mean-field electrodynamics" the authors show that these fluctuations possess a net amount of current helicity, and find that a necessary condition for dynamo action is that the turbulent current helicity and the current helicity in the large-scale field be of opposite sign.

26061 **A review of broad-band electrostatic waves in the magnetotail.** Grabbe, C.L. (Dept. of Physics and Astronomy, Univ. of Iowa, Iowa City, IA 52242-1410). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 902-909(Dec 1986).

Recent results showing that ions beams are the cause of generating broad-band electrostatic waves in the magnetotail, as well as theoretical work in good agreement with the spectrum observed, is reviewed. The implications of this for the transport and other dynamics of the magnetotail are discussed.

26062 **Time-dependent interaction between space plasmas and transverse magnetic fields.** Peter, W. (Los Alamos National Lab., Los Alamos, NM 87544). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 6, 925-928(Dec 1986).

A time-dependent one-dimensional analytic model is presented describing the dynamics of a plasma and a magnetic field in relative motion to each other. It is found that the interface between the plasma and field deteriorates in a way that is analogous to the Rayleigh-Taylor instability for a plasma in equilibrium. The growth rate of the perturbations is identical to the classical Rayleigh-Taylor (kg)/sup 1/2/ scaling, except that the gravity g is not a constant, but is proportional to the magnetic field strength and the square root of the plasma velocity. Applications to space physics and astrophysical phenomena are presented.

26063 **Microtheory of collisionless shock current layers.** Winske, D. (Los Alamos National Lab., NM). pp 225-236 of Collisionless shocks in the heliosphere: reviews of current research. Washington, DC; American Geophysical Union (1985).

The present status of understanding of microscopic dissipation processes in the current layer of collisionless shocks is reviewed. The emphasis is on cross-field current-driven instabilities and their importance in quasi-perpendicular shocks, although other processes which arise in quasi-parallel shocks are also discussed. 106 references, 1 figure.

26064 **Electron velocity distributions near collisionless shocks.** Feldman, W.C. (Los Alamos National Lab., NM). pp 195-205 of Collisionless shocks in the heliosphere: reviews of current research. Washington, DC; American Geophysical Union (1985).

Recent studies of the amount of electron heating and of the shapes of electron velocity distributions across shocks near the earth are reviewed. It is found that electron heating increases with increasing shock strength but is always less than the ion heating. The scale length of electron heating is also less than that for the ions. Two-dimensional cuts through electron velocity distributions show characteristic shapes which depend on the strength of the shocks. At the weaker shocks, electron heating is mostly perpendicular to the ambient magnetic field B and results in Gaussian-shaped velocity distributions at low-to-moderate energies. At the stronger shocks, parallel heating predominates, resulting in flat-topped velocity distributions. A reasonable interpretation of these results indicates that at the weaker shocks, electron heating is dominated by a tendency toward conservation of the magnetic moment. At the stronger fast mode shocks, this heating is thought to be dominated by an acceleration parallel to B produced by the macroscopic shock electric field followed by beam-driven plasma instabilities. Some contribution to the heating at the stronger shocks from conservation of the magnetic moment and cross-field current-driven instabilities cannot be ruled out. Although the heating at slow mode shocks is also dominated by instabilities driven by magnetic field-aligned electron beams, their acceleration mechanism is not yet established. 32 references, 15 figures.

26065 **Simulation of quasi-parallel collisionless shocks.** Quest, K.B. (Los Alamos National Lab., NM). pp 185-194 of Collisionless shocks in the heliosphere: reviews of current research. Washington, DC; American Geophysical Union (1985).

Progress in the numerical simulation of quasi-parallel shocks is reviewed. Recent work on one-dimensional hybrid codes (fluid electrons, particle ions) and two-dimensional particle codes is emphasized. Basic goals and limitations of the various models are stated throughout the text. 53 references, 7 figures.

26066 **Drift dissipative instability: a critique.** Gary, S.P. (Los Alamos National Lab., NM). *Journal of Atmospheric and Terrestrial Physics;* **46**: No. 8, 685-687(1984).

This paper is a critique of Kadomtsev's fluid dispersion equation for electrostatic drift instabilities in a plasma with weak BGK charged-neutral collisions. The numerical solution of this equation is compared with the solution of a more exact kinetic dispersion equation. At maximum growth rate, the fluid results do not correspond to the kinetic results in either the collisionless or the collision-dominated limits. Thus in the BGK model of charged-neutral collisions, the drift dissipative instability is not a distinct mode, but only an approximation to the universal density drift instability in a limited range of parameter space. 7 references, 1 figure.

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REFER ALSO TO CITATION(S) 25196, 25379, 25460, 25465, 25723, 25728, 26236, 26252, 26282

26067 **(BNL—39397) Polarized H^- source development at BNL.** Kponou, A.; Alessi, J.G.; Hershcovitch, A.; Niinikoski, T.O. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 8p. (CONF-8610115—24). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006749.

From 4. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (27 Oct 1986).

A polarized H^- source has been in operation at BNL for several years. It produces 500 μs pulses of ~40 μA H^- with polarization of ~75% measured at 200 MeV. Normal operation is at 0.5 Hz, but the source has recently been operated at 5 Hz with encouraging results. Progress in developing a milliampere source is reported.

26068 **(BNL—39452) Progress toward a milli-ampere nuclear polarized H^- source.** Hershcovitch, A.; Alessi, J.G.; DeVito, B.; Kponou, A.; Niinikoski, T. (Brookhaven National Lab., Upton, NY (USA)). 1987. Contract AC02-76CH00016. 7p. (CONF-870302—86). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007633.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

A new polarized H^- source producing currents at the milli-Ampere level was designed and is presently being assembled at BNL. This source is composed of three novel elements which have been developed separately. A cold atomic beam yielded H^0 fluxes as high as 9.4 x 10^{18} and 4 x 10^{19} atoms/s-sr at accommodator temperatures of 5.8 K and 26 K, respectively. A superconducting solenoid for spin selection designed to have an acceptance angle of 0.1 sr for this atomic beam was developed. A ring magnetron ionizer, which converts H^0 to polarized H^- by charge exchange with 200 eV D^-, yielded 500 μA of H^- for an estimated H^0 density of 10^{12} cm^{-3}. A successful matching and assembling of these elements should result in a milli-Ampere polarized H^- source.

26069 **(CONF-870152—2) Heavy ion storage rings.** Schuch, R. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007660.

From Workshop on opportunities for atomic physics using slow highly-charged ions; Argonne, IL, USA (12 Jan 1987).

A brief overview of synchrotron storage rings for heavy ions, which are presently under construction in different accelerator laboratories is given. Ions ranging from protons up to uranium ions at MeV/nucleon energies will be injected into these rings using multiturn injection from the accelerators available or being built in these laboratories. After injection, it is planned to cool the phase space distribution of the ions by merging them with cold electron beams or laser beams, or by using stochastic cooling. Some atomic physics experiments planned for these rings are presented.

26070 **(CONF-870516—1) Effect of temperature on the uniform field breakdown strength of electronegative gases.** Christophorou, L.G.; Mathis, R.A.; Hunter, S.R.; Carter, J.G. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA). Dept. of Physics). Mar 1987. Contract AC05-84OR21400. 8p. NTIS, PC A02. File Number DE87006623.

From 5. international symposium on gaseous dielectrics; Knoxville, TN, USA (3 May 1987).

In general, the electron attachment rate constant, k/sub a/ (<ϵ>,Y), as a function of the mean electron energy <ϵ> and temperature Y for electronegative gases which attach electrons nondissociatively decreases greatly with Y from room temperature to Y ≦ 600K, while that for electronegative gases which attach electrons dissociatively increases with increasing Y. Based on recent studies in our laboratory on k/sub a/ (<ϵ>,Y), we investigated the variation with Y (~295-575K) of the uniform field breakdown strength, (E/N)/sub lim/, for three classes of electronegative gases: (a) gases such as c-C_4F_8 (and c-C_4F_6, 1-C_3F_6) which attach strongly low-energy (≦ 1 eV) electrons nondissociatively and for which k/sub a/ (<ϵ>,Y), decreases precipitously with Y above ambient; (b) gases such as C_2F_6 and CF_3Cl which attach electrons exclusively dissociatively and whose k/sub a/ (<ϵ>,Y) increases with Y; and (c) gases such as C_3F_8 and n-C_4F_{10} which attach electrons both nondissociatively and dissociatively over a common low-energy range and whose k/sub a/ (<ϵ>,Y) first decreases and then increases with Y above ambient. The (E/N)/sub lim/(Y) has been found to decrease significantly with Y for (a), to decrease slowly with Y for (c), and to increase slightly with Y for (b). These changes in (E/N)/sub lim/ follow those in k/sub a/ (<ϵ>,Y). A similar behavior is expected for other electronegative gaseous dielectrics in the respective three groups.

26071 **(CONF-8508100—3) The study of atomic three-body problems in hyperspherical coordinates.** Lin, C.D. (Kansas State Univ., Manhattan (USA). Dept. of Physics). Aug 1985. Contract FG02-86ER13596. 37p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007920.

From International symposium on few-body methods and their applications in atomic, molecular and nuclear physics and chemistry; Nanning, China (4 Aug 1985).

In this review the application of hyperspherical coordinates is discussed for the solution of some of the typical atomic and molecular problems, and the new physical insights obtained from such studies are shown. In particular, it is shown how correlations between two excited electrons can be conveniently understood in terms of the surface harmonics at a constant hyperradius and visualized by displaying the surface charge densities on the angular coordinates that describe radial and angular correlations. It is shown that a new set of correlation quantum numbers K, T and A for any two-electron states can be deduced by analyzing the surface harmonics; here K and T describe angular correlation and A = +1, -1 or 0) describes radial correlation. Because of the isomorphic correlations, states which have A = +1 or -1 are shown to exhibit supermultiplet structure while states which have A = 0 are shown to behave like singly excited states. Therefore this classification scheme includes the independent particle approximation as a subset. The relations of these quantum numbers to the collective vibrations and rotations of molecule-like normal modes are also discussed. Applications of hyperspherical harmonics to the three-body breakup and linear triatomic collisions are also discussed briefly. 57 refs., 15 figs.

26072 (DOE/ER/10676—9) Semiempirical studies of atomic structure: Progress report, April 2, 1986-February 15, 1987. Curtis, L.J. (Toledo Univ., OH (USA). Dept. of Physics and Astronomy). Mar 1987. Contract AS05-80ER10676. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007320.

Studies of the structure and properties of highly ionized many electron atoms are proceeding through a combination of experimental measurements, semiempirical modeling and systematizations, and ab initio theoretical calculations. Atomic systems which have both many electrons stripped away and many electrons remaining often occur as contaminants or controlled impurities in high temperature plasmas, but information on their spectroscopic properties remains fragmentary. Spectroscopic classifications require accuracies exceeding parts per million, which cannot be achieved by standard ab initio methods for these complex systems. Semiempirical systematizations of high precision data can provide these accuracies, and an increasing base of this data is becoming available through studies utilizing fast ion beam excitation, laser and tokamak produced plasmas, astrophysical sources, and conventional spectroscopic sources. This program seeks to acquire, systematize, and parametrize large blocks of data along, e.g., isoelectronic, homologous, isoionic, isonuclear, Rydberg, and yrast series for the exposition of predictive empirical regularities. Trends revealed are then tested through well chosen experimental measurements, and ab initio methods are used to seek quantitative understanding of the empirical regularities.

26073 (DOE/ER/13191—7) Kinetic studies following state-selective laser excitation: Annual performance report for period March 15, 1986-March 31, 1987. Keto, J.W. (Texas Univ., Austin (USA). Dept. of Physics). Oct 1986. Contract FG05-84ER13191. 53p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007938.

Three general areas of energy transfer are discussed: (1) the direct measurement of state-to-state reaction rates by measuring time dependent loss of reactants and products, (2) studies of rovibrationally resolved spectral studies in supersonic beams, and (3) laser assisted collisions. Specifically results are presented for reactions of $Xe^*(5p^5 6p)$ with Cl_2, optical collisions of $Xe^* 6p[1/2]_0$, and high resolution of xenon and cesium dimers. (WRF)

26074 (DOE/ER/13557—1) Velocity modulation electronic absorption spectroscopy: Progress report. Hale, B.C. (Jackson State Univ., MS (USA). Dept. of Chemistry). Mar 1987. Contract FG05-86ER13557. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007764.

Molecular ions produced in an ac glow discharge cell will be probed with a single frequency tunable dye laser. The electronic-vibration-rotation spectra can be obtained by exploiting the small, but detectable, Doppler shift ($\Delta V/V \sim 10^{-6}$).

26075 (DOE/ER/13596—3) Alignment and polarization of H(2p) following H^+-He collisions studied using a unified AO-MO matching method. Kimura, M.; Lin, C.D. (Joint Inst. for Lab. Astrophysics, Boulder, CO (USA); National Bureau of Standards, Boulder, CO (USA); Kansas State Univ., Manhattan (USA). Dept. of Physics). 1986. Contract FG02-86ER13596. 3p. (CONF-860833—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007917.

From 10. international conference on atomic physics; Tokyo, Japan (25 Aug 1986).

It is shown that the recently developed unified AO-MO matching method for ion-atom collisions is capable of providing details of the collision dynamics. This method is used to calculate the alignment and orientation parameters of H(2p) in p-He collisions and to show that the results are in good agreement with experimental measurements. In this AO-MO matching method, the time-dependent electronic wave function is expanded in terms of traveling atomic orbitals (AO) of the two collision centers at larger internuclear separations which is matched to the solution in the inner region where it is expanded in terms of molecular orbitals (MO) without any translational factors. In this calculation six σ and two π states are included in the MO expansion, and in the AO expansion the ground state, $2\ ^1S$ and $^12\ P$ of helium and 1s, 2s and 2p states of hydrogen are included.

26076 (DOE/ER/13596—7) Atomic physics of strongly correlated systems: Progress report, 1 January 1986 through 1 March 1987. Lin, C.D. (Kansas State Univ., Manhattan (USA). Dept. of Physics). Mar 1987. Contract FG02-86ER13596. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007538.

Brief summaries are given for the following research: (1) electric dipole formulas in hyperspherical coordinates with applications to H^{-1} and He, (2) molecular rovibrational modes of doubly excited states in hyperspherical coordinates, (3) charge transfer and excitation in p-He collisions, (4) electron capture in C^{6+} and O^{8+} on He at intermediate energies, and (5) atomic-orbital expansion study for C^{6+} and O^{8+} on He. (WRF)

26077 (DOE/EV/04361—1) Fluorescent and Raman scattering by molecules embedded in small particles: Final report. Chew, H.; McNulty, P.J. (Clarkson Coll. of Tech., Potsdam, NY (USA). Dept. of Physics). Feb 1987. Contract AC02-77EV04361. 15p. NTIS, PC A02. File Number DE87007759.

The model takes into account the physical properties and the morphology of the particles, as well as the locations of the scatter(s). Brief descriptions of various applications of the model are presented. Brief descriptions of experimental studies of scattering by finite dielectric and cylindrical microstructures in plastic track detector plane surfaces are given. (WRF)

26078 (LA—10776-MS) Some comments on molecular partition functions. Sharp, C.M. (Los Alamos National Lab., NM (USA)). Mar 1987. Contract W-7405-ENG-36. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007709.

In models of cool stellar atmospheres where molecules are important, molecular spectroscopic data can be used to calculate partition functions, from which equilibrium constants hence abundances can be obtained. In this report, it is shown that simple analytic approximations can be used to calculate very easily the partition functions of diatomic molecules, and comparisons are made for the two particularly important astrophysical molecules, H_2 and CO, with other work where the partition functions are calculated by explicitly summing over a very large number of energy levels. It is found that these analytic approximations give excellent agreement with more detailed calculations and are certainly adequate for many purposes. This method is very convenient, as only a few spectroscopic constants are needed, and the analytic formulae are very easily evaluated.

26079 (LA—10953-MS) The f electron collapse revisited. Bennett, B.I. (Los Alamos National Lab., NM (USA)). Mar 1987. Contract W-7405-ENG-36. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007713.

A reexamination of the collapse of 4f and 5f electrons in the lanthanide and actinide series is presented. The calculations show the well-known collapse of the f electron density at the thresholds of these series along with an f^2 collapse between thorium and protactinium. The collapse is sensitive to the choice of model for the exchange-correlation potential and the behavior of the potential at large radius.

26080 **(LA-UR—87-798) Laser-guiding of relativistic electron beams with applications to flash x-radiography.** Carlson, R.L. (Los Alamos National Lab., NM (USA)). Mar 1987. Contract W-7405-ENG-36. 4p. (CONF-870302—60). NTIS, PC A02. File Number DE87007502.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

The technique of guiding a relativistic electron beam by utilizing an ultraviolet-laser-ionized channel in low-pressure benzene has been demonstrated on an rf linear accelerator. Detailed measurements of the temporal behavior of the beam as it propagated a distance of 13.5 m were made as a function of laser channel parameters and accelerator conditions. Concepts and applications of this laser-guiding technique are presented as they relate to the possible improvement and simplification of the generation, transport, and focusing of relativistic electron beams used to create bremsstrahlung radiation for flash x-radiography.

26081 **(LA-UR—87-810) A pulsed electron injector using a metal photocathode irradiated by an excimer laser.** Kauppila, T.J.; Builta, L.A.; Crutcher, J.K.; Elliott, J.C.; Moir, D.C. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 3p. (CONF-870302—61). NTIS, PC A02. File Number DE87007499.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

The hot cathode of an electron gun is replaced by a metallic photocathode driven by an excimer laser. The current, current density, and emittance of the 500-kV electron beam produced by the photoelectron source are presented. In addition, the temperature of the photocathode is varied to study the possibility of a hybrid source.

26082 **(LA-UR—87-890) Direct measurement of a proton beam passing through a water target by the induced change in the water conductivity.** Dombeck, T.; Finch, A.; Grisham, D.L. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 3p. (CONF-870302—22). NTIS, PC A02. File Number DE87007486.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

A water target for use in a neutrino experiment at the Los Alamos Meson Physics Facility was constructed with monitors to measure the transient change in water conductivity induced by the passage of the proton beam. This novel monitoring technique permitted a direct measure of the 800-MeV incident proton beam inside the target and gave a measure of the beam alignment. The conductivity persisted over many milliseconds and exhibited an exponential time decay after the beam pulse ended with a characteristic time constant consistent with the production and recombination of OH^- and H_3O^+ ions in the water. Though the concentration of these ions was observed to increase linearly with the incident proton current, when compared to the formation of ion-pairs by direct energy loss of the incident protons, the process producing the more stable conduction ions observed in this experiment was found to be many orders of magnitude less efficient. The cause of this inefficiency is not understood, but suggests one or more intermediate processes are involved in their production.

26083 **(UCRL—91913) Time resolved emittance measurements with a freely expanding electron beam.** Struve, K.W.; Chambers, F.W.; Clark, J.C. (Lawrence Livermore National Lab., CA (USA)). 13 May 1985. Contract W-7405-ENG-48. 5p. (CONF-850504—314). NTIS, PC A02. File Number DE87007057.

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Time resolved rms emittance measurements have been made on the ETA by allowing the electron beam to freely expand into a magnetic field free vacuum region while measuring beam size versus time with x-ray probes at three axial positions. The beam is not required to be at a waist. Temporal resolution is limited only by the beam size measurement technique, which for the x-ray probe technique is subnanosecond. The analysis consists of matching parameters of the beam envelope equation with measured radii. Space charge effects were ignored since they were small for this experiment. They can be easily included but the resulting envelope equation must be solved numerically. Emittance measurements of the wire zone conditioned electron beam will be given.

26084 **(UCRL—94926) Dynamics of heavy ion beams during longitudinal compression.** Ho, D.D.M.; Bangerter, R.O.; Lee, E.P.; Brandon, S.; Mark, J.W.K. (Lawrence Livermore National Lab., CA (USA); Lawrence Berkeley Lab., CA (USA)). 13 Mar 1987. Contract W-7405-ENG-48. 5p. (CONF-870302—18). NTIS, PC A02. File Number DE87007092.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

Heavy ion beams with initially uniform line charge density can be compressed longitudinally by an order of magnitude in such a way that the compressed beam has uniform line charge density and velocity-tilt profiles. There are no envelope mismatch oscillations during compression. Although the transverse temperature varies along the beam and also varies with time, no substantial longitudinal and transverse emittance growth has been observed. Scaling laws for beam radius and transport system parameters are given.

26085 **Cl-Kβ emission of chloromethanes and comparison with semiempirical and ab initio MO calculations.** Perera, R.C.C.; LaVilla, R.E.; Gibbs, G.V. (Center for X-ray Optics, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Journal of Chemical Physics;* **86**: No. 9, 4824-4830(1 May 1987). Contract AC03-76SF00098.

The chlorine Kβ emission in fluorescence from gas/vapor phase CCl_4, $CHCl_3$, CH_2Cl_2, and CH_3Cl were measured with "good statistics" and previously undetected weak x-ray emission features were observed. Results from ground state minimal and extended basis set ab initio (STO-3G) and MNDO MO calculations for these molecules are presented. The chlorine Kβ emission spectra were analyzed by comparison with complementary spectral data and the MO calculations. In addition, weak features in Cl-Kβ emission spectra resulting from self-absorption in the sample were identified.

26086 **AgH, Ag_2, and AgO revisited: Basis set extensions.** Martin, R.L. (Theoretical Division, MSJ569, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Chemical Physics;* **86**: No. 9, 5027-5031(1 May 1987). Contract W-7405-ENG-36.

An extended basis set has been developed for Ag which significantly improves the agreement between theoretical and experimental spectroscopic parameters for AgH, AgO, and Ag_2. The major improvement comes about as a result of the improved treatment of electron correlation in the Ag d shell upon the introduction of f functions. Their inclusion produces very slight differences at the SCF level, but significant reductions in r/sub e/ and increases in ω/sub e/ and D/sub e/ in the Mo-dash-barller—Plesset perturbation theory expansion. At the MP4(SDTQ) level, typical results are 0.02 A too long for r/sub e/, 4% too low for ω/sub e/, and 10 kcal too small for D/sub e/. From a pragmatic standpoint, MP2 give results very similar to this at a much reduced level of effort.

26087 **High-order correction to the Trotter expansion for use in computer simulation.** Li, X.; Broughton, J.Q. (Department of Physics, SUNY at Stony Brook, Stony Brook, New York 11794). *Journal of Chemical Physics;* **86**: No. 9, 5094-5100(1 May 1987).

A convenient form of the generalized Trotter formula for path-integral simulations has been investigated for various systems and proves to be much better than the primitive. The hydrogen atom, which is pathological for the primitive algorithm, is solved by the new method but the results are not completely satisfactory.

26088 Vanishing effect in post-collision interaction during photon-excited Coster-Kronig decay. Armen, G.B.; Sorensen, S.L.; Whitfield, S.B.; Ice, G.E.; Levin, J.C.; Brown, G.S.; Crasemann, B. (Department of Physics and Chemical Physics Institute, University of Oregon, Eugene, Oregon 97403). *Physical Review [Section] A: General Physics;* **35**: No. 9, 3966-3969(1 May 1987).

In radiationless transitions to atomic inner-shell hole states produced by threshold photoionization, the Auger electron energy is shifted up by post-collision interaction between the two continuum electrons. According to both semiclassical and quantum-mechanical models, this shift is expected to disappear if the photoelectron energy exceeds that of the Auger electron (the vanishing or "no-passing" effect). This effect, recently observed for a long-lived [4d] hole state of Xe, is now also demonstrated for the very fast Xe L_2-L_3N_4 (J = 3) Coster-Kronig transition, excited with synchrotron radiation.

26089 Tests of approximations for inelastic molecule—surface scattering dynamics. Diestler, D.J.; Riley, M.E. (Department of Chemistry, Purdue University, West Lafayette, Indiana 47907). *Journal of Chemical Physics;* **86**: No. 9, 4885-4894(1 May 1987).

Any classical dynamical simulation of atom— or molecule—surface scattering is subject to the approximation of truncating the many-body description of the solid to that of a tractable number of atoms (the P zone). This truncation should have no significant effect on the collision dynamics, e.g., the accommodation coefficients and sticking probabilities, for the situation of interest. No ab initio tests of the accuracy of the few existing approximate treatments of gas—surface scattering appear to have been reported. In this work we review the existing approximations and introduce three new ones. One of the three new ones, the weak-coupling approximation, assumes the solid atoms tend to respond independently to the incident molecule; another, the bond-corrected Debye approximation, is a simple modification of the Adelman—Doll damping theory; the third, the outgoing wave approximation, treats the solid as an elastic continuum, in which the wave-like disturbance created by the collision is propagated outwardly from an epicenter near the point of impact. In all, six different approximations are applied to a collision system (adatom interacting via a Morse potential with the simple-cubic Rosenstock—Newell lattice at 0 K) for which numerically exact scattering data (energy accommodation coefficients) are available. Figures of merit are assigned to each approximation over a wide range of collisional parameters. The new outgoing wave approximation is consistently of the highest quality. The results are very encouraging for the easy application of reliable approximations to P zones with only a few atoms

26090 Kinetics of muonic helium in muon-catalyzed d-d and d-t fusion. Cohen, J.S. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review Letters;* **58**: No. 14, 1407-1410(6 Apr 1987).

An accurate kinetics treatment is applied to the muonic helium atoms formed by a muon's sticking to the charged particle produced in muon-catalyzed d-d and d-t fusion. Cross sections for l- and n- changing transitions are included to describe density-dependent stripping and x-ray production. Coupled with recent accurate calculations of the initial sticking, the results are generally in very good agreement with experiments. The noteworthy exception is that the density dependence of the sticking is much weaker than previously observed, in agreement with preliminary results of a new experiment.

26091 Giant resonance effects in the electron-impact ionization of heavy atoms and ions. Younger, S.M. (A-Division, Lawrence Livermore National Laboratory, Livermore, California 94550). *Physical Review [Section] A: General Physics;* **35**: No. 7, 2841-2851(1 Apr 1987). Contract W-7405-ENG-48.

The origin of giant resonance effects in the electron-impact ionization of heavy ($Z>50$) atoms and ions is discussed in terms of the potentials governing the scattering states. Calculations are presented for electron-impact ionization of the 4d subshell in Xe, Cs^+, Ba/sup 2+/, Xe^+, and I^+, and for ionization of the 4f subshell in Eu^+, Tm^+, Yb/sup 2+/, Lu/sup 3+/, and W^+. .AE

26092 Optically enhanced electron attachment. Christophorou, L.G.; Hunter, S.R.; Pinnaduwage, L.A.; Carter, J.G.; Christodoulides, A.A.; Spyrou, S.M. (Atomic, Molecular, and High Voltage Physics Group, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6123). *Physical Review Letters;* **58**: No. 13, 1316-1319(30 Mar 1987). Contract AC05-84OR21400.

The first optically enhanced electron attachment involving electronically excited molecules is reported. The metastable (triplet) states responsible for the photoenhanced electron attachment were produced indirectly via internal conversion from higher excited singlet states which are strongly optically allowed and are reached by excimer-laser excitation.

26093 (LA-tr—87-5) AXCEL: Interactive simulation program to compute two-dimensional potential distributions of electrostatic arrangements and of ion paths in electrostatic fields under consideration of space charging. Spedtke, P. (Los Alamos National Lab., NM (USA); Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). 1987. Contract W-7405-ENG-36. Translation source information not available . 66p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007760.

The AXCEL program optimizes transport paths for charged particles and extraction geometries for ion sources with planar or cylindrical symmetry. In the first iteration the Laplace equation is solved, and in later iterations the Poisson equation is solved. After each iteration the charge distribution is determined anew. If the solution of the Poisson equation converges to the solution of the time-constant Vlasov equation, then a self-consistent solution is obtained for the potential problem with space charging. 38 refs., 22 figs. (WRF)

26094 Dirac scattered wave calculations. Yang, C.T.; Case, D.A. (Surface Analytic Research Inc., Mountain View, CA). pp 643-664 of Local density approximations in quantum chemistry and solid state physics. Dahl, J.P.; Avery, J. New York, NY; Plenum Press (1986). (CONF-8206289—).

From Local density approximations in quantum chemistry and solid state theory conference; Copenhagen, Denmark (10 Jun 1982).

The self-consistent-field-Xalpha-Dirac-scattered wave method is briefly reviewed. The method treats relativistic effects fully within the one-electron local exchange framework. Examples of this method's results illustrate the versatility of the method, and its potential impact on studies of transition metal complexes and surfaces.

26095 Molecular-dynamics calculations of the velocity autocorrelation function: hard-sphere results. Erpenbeck, J.J.; Wood, W.W. (Los Alamos National Lab., NM). *Physical Review [Section] A: General Physics;* **32**: No. 1, 412-422(Jul 1985).

The velocity autocorrelation function for the hard-sphere fluid is computed for ten values of the volume ranging from 25 to 1.6 times the close-packed volume V_0 for systems of from 108 to 4000 hard spheres, using a Monte Carlo, molecular-dynamics technique. The results are compared with the theoretical predictions of the mode-coupling theory, modified to take into account the finite size of the system and the periodic boundary conditions. The data are found to be in good agreement with the theory, evaluated using Enskog values for the transport coefficients, for values of the time greater than roughly 15 to 30 mean free times (depending on density), for volumes as small as 2 V_0. The higher-density results do not agree with the theory, unless the actual transport coefficients are used in the theory. The latter version of the theory, however, fails to fit the data at lower densities, except at very long times. To answer the recent critique by Fox, the data are further compared with the theory over time intervals for which the molecular-dynamics trajectories retain some measure of accuracy. The agreement between the data and the theory is largely unaffected, except at a volume 1.8 V_0 for which there is a marginally significant difference at very long times only. 12 references, 10 figures, 4 tables.

26096 Observations on the spectral dependence and T/D isotope selectivity in the CO_2 laser multiple-photon dissociation of trifluoromethane. Magnotta, F.; Herman, I.P. (Lawrence Livermore National Lab., CA). *Applied Physics,* [*Part*] *B: Phtophysics and Laser Chemistry;* **36**: 207-212(1985). Contract W-7405-ENG-48.

Pulsed CO_2 laser multiple-photon dissociation of CTF_3 (nu_2 mode) bathed in argon and CDF_3, CHF_3 or CCl_4 is examined as a function of laser wavelength (9.2-9.6 μm) and fluence. The dependence of the dissociation profile on wavelength is analyzed and comparisons are made to prior work. The single-step T/D enrichment factor for infrared photolysis of trifluoromethane is measured; potential practical isotope separation is discussed. Pulsed infrared laser photolysis of CTF_3 (nu_5 mode) using a 12 μm NH_3 laser is also attempted. 34 references, 2 figures.

26097 Multiparticle 3D imaging technique to study the structure. Koenig, W.; Faibis, A.; Kanter, E.P.; Vager, Z.; Zabransky, B.J. (Argonne National Lab., IL). *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms;* **B10/11**: 259-265(1985). Contract W-31-109-ENG-38.

When energetic molecular ions (E/sub ion/ = 0.1-0.5 MeV/amu) pass through thin solid targets a Coulomb explosion ensues due to the rapid ($\sim 10^{-17}$ s) stripping of the valence electrons. This process has been successfully used to derive stereochemical information on diatomic and on selected triatomic ions. In order to investigate more complex molecular ions as well as to obtain more accurate and detailed structure information, a large area, multiparticle, position- and time-sensitive detector has been developed to detect all atomic fragments in coincidence. The requirement of multiparticle detection independent of the relative particle positions leads to a rather complex data readout and - reduction system containing ~650 analog-to-digital conversions per event. The system relies heavily on techniques developed for high energy physics experiments during recent years. The single event resolution of the apparatus with respect to bond-lengths and -angles has been studied by Monte Carlo simulations and is typically a few percent. 9 references, 7 figures.

26098 Asymmetric broadening of Se(3d/sub 5/2/) XPS spectra of $(TMTSF)_2ClO_4$ and $(TMTSF)_2ReO_4$. Thorn, R.J.; Carlson, K.D.; Wang, H.H.; Williams, J.M. (Argonne National Lab., IL). *Molecular Crystals and Liquid Crystals;* **119**: 233-236(1985). Contract W-31-109-ENG-38.

A comparison of the x-ray photoelectron spectra in TMTSF, $(TMTSF)_2ClO_4$, and $(TMTSF)_2ReO_4$ shows that the spectra of Se(3d/sub 5/2/) for the first is nearly symmetrical, whereas those for the other two are broadened asymmetrically. The broadening is associated with polarization of the selenium by the anion. 6 references, 1 figure.

26099 Wavelength of the $4s^2\ {}^1S_0$-$4s4p\ {}^3P_1$ intercombination line in Br VI. Curtis, L.J.; Martinson, I.; Leavitt, J.A.; Dietrich, D.D.; Bashkin, S.; Denne, B. (Univ. of Toledo, OH). *Physics Letters* [*Section*] *A;* **105A**: No. 4-5, 212-214(15 Oct 1984). Contract AS05-80ER10676.

A beam-foil measurement of the wavelength of the Br VI $4s^2\ {}^1S_0$-$4s4p\ {}^3P_1$ intercombination transition has been made which corrects an earlier error. The new value of 946.3(2) A is 6.7 A longer than the previously accepted value, and the excitation energies of all triplet levels in Br VI should correspondingly be adjusted downward by 756 cm^{-1}. 16 references, 2 figures, 1 table.

26100 Polarizability of $5s^25p$ (${}^2P$/sub 1/2/) atomic indium. Guella, T.P.; Miller, T.M.; Bederson, B.; Stockdale, J.A.D.; Jaduszliwer, B. (New York Univ., NY). *Physical Review* [*Section*] *A: General Physics;* **29**: No. 6, 2977-2980(Jun 1984).

The authors have measured the static electric dipole polarizability of ground state ${}_{49}{}^{115}In$ $5s^25p({}^2P$/sub 1/2/) with a small (~ 9%) admixture of metastable $5s^25p({}^2P$/sub 3/2/). Three different methods were used: (a) E-H gradient balance, (b) comparison of deflection in an inhomogeneous electric field with an alkali-metal-atom standard, and (c) a deflection analysis using a computer program with no adjustable parameters except the polarizability itself. All methods agree to within 11%. Their weighted final result is (10.18 +/- 1.20) x 10^{-24} cm^3. This is in very close agreement to a recent computation by Liberman and Zangwill, using fully relativistic wave functions and including electron correlation. 14 references, 5 figures.

26101 $4s^24p\,{}^2P$ intervals in the Ga isoelectronic sequence from Rb^{6+} to In^{18+}. Curtis, L.J.; Reader, J.; Goldsmith, S.; Denne, B.; Hinnov, E. (Univ. of Toledo, OH). *Physical Review* [*Section*] *A: General Physics;* **29**: No. 4, 2248-2250(Apr 1984). Contract AI01-76PR06010;AC02-76CH03073;AS05-80ER10676.

Measurements of the fine-structure splitting of the $4s^24p\ {}^2P$ ground-state term of the gallium isoelectronic sequence using low-inductance sparks, laser-produced plasmas, and tokamak plasma sources are presented. The observations are in excellent agreement with semiempirical predictions using screening parametrizations, and permit a refinement of these predictions. 17 references, 1 figure, 1 table.

26102 Use of scaled orbital functions in self-consistent field calculations for atoms. Liberman, D.A. (Los Alamos National Lab., NM). *International Journal of Quantum Chemistry, Quantum Chemistry Symposium;* **18**: 359-368(1984).

If a set of orbital functions phi/sub i/(r) is an approximate solution to the self-consistent field equations for an atom, the scaled orbital functions Psi/sub i/(r) = λ/sub i//sup 3/2/phi/sub i/(λ/sub i/r) will be a better solution if the scale parameters λ/sub i/ are properly chosen. The best choice of the scale parameters is determined by the variational principle. Two applications of this idea are made in this paper: one is an improved iteration scheme for solving the self-consistent field equations; the other is the calculation of the effects of relaxation when an electron is moved from one shell of an atom to another or is removed from the atom. In the first application the number of iterations required to converge the self-consistent field process is reduced by about two-thirds over the usual methods. In the second application, a sample calculation for argon shows the relaxation energies on ionization being calculated to within 0.5 eV. 5 references, 2 tables.

26103 Lifetime measurements in highly ionized atoms. Curtis, L.J. (Univ. of Toledo, OH). *Physica Scripta;* **T8**: 77-83(1984). Contract AS05-80ER10676.

Recent developments in the measurement of lifetimes of excited states in highly ionized atoms using fast ion beam excitation methods are reviewed. The applicability and precision of these methods are discussed in the context of specific measurements and compared with existing theoretical capabilities. 85 references, 6 figures.

26104 Self-consistent core potentials for complex atoms: a semiclassical approach. Curtis, L.J.; Silbar, R.R. (Univ. of Toledo, OH). *Journal of Physics B: Atomic and Molecular Physics;* **17**: 4087-4101(1984). Contract AS05-80ER10676.

A semiclassical self-consistent field method for specification of the structure of a complex atom is developed. The procedure utilizes classical position probability densities and a modern version of the Bohr-Sommerfeld-Wilson quantization condition. The semiclassical results are compared with non-relativistic quantum mechanical Hartree-Fock calculations, and energy eigenvalues and average values are found to be in remarkably close agreement. A relativistic extension of the semiclassical method is used to investigate the fine structure of highly ionized members of the Cu isoelectronic sequence. The calculations suggest two ways in which the observed break near Z = 60 in the screening parameterization of this system could occur. 44 references, 3 figures, 2 tables.

26105 Nonlinear coupling of radiation pulses to absorbing anharmonic molecular media. Shore, B.W.; Eberly, J.H. (Lawrence Livermore National Lab., CA). pp 69-94 of Coupled nonlinear oscillators. Chandra, J.; Scott, A.C. (eds.). Amsterdam, Netherlands; North-Holland Publishing Company (1983).

The authors discuss the nonlinear mutual coupling of radiation and molecules, with emphasis on the effects on radiation pulse propagation. The authors treat the nonlinear propagation problem numerically, with particular attention to both continuum and discrete behavior associated with the quasi-continuum model of molecular absorbers. 14 references, 19 figures.

26106 **Effects of resonance-resonance coupling on dissociative electron attachment.** Hazi, A.U. (Lawrence Livermore National Lab., CA). *Journal of Physics B: Atomic and Molecular Physics;* **16**: L29-L34(1983). Contract W-7405-ENG-48.

The author proposes a new interpretation of the interaction between the ²Sigma/sub 1/2/⁺ and ²II/sub 1/2/ electronic resonance states of hydrogen halide anions which has been observed in recent experiments on dissociative electron attachment to HBr. The two resonances are shown to interact in second order via electronic coupling to the non-resonant scattering continuum. The magnitude of the effect increases with increasing spin-orbit mixing between the states. 13 references.

26107 **Carbon KVV Auger spectroscopy using a plane-grating monochromator at the National Synchrotron Light Source.** Johnson, P.D.; Farrell, H.H.; Smith, N.V. (Bell Labs., Murray Hill, NJ). *Vacuum;* **33**: No. 10-12, 775-778(1983).

The authors report on their first adsorption studies using a plane-grating monochromator (PGM) at the National Synchrotron Light Source (NSLS) at Brookhaven. This is one of several new beam lines providing access to the photon energy region around and above the carbon K-edge (~ 285 eV). Specifically the authors report observations of the Carbon KVV Auger contribution to the photoemission energy spectra for CO adsorbed on Pd(111) on passing through the resonance for excitation of C 1s electrons into the unoccupied 2π bound state of the CO molecule. The results show no conspicuous evidence for the recently proposed enhancement mechanism involving 2π spectator electrons. The effectiveness of core-hole screening can be estimated by comparison with inverse photoemission observations of the 2π orbital. 8 references, 5 figures.

26108 **Closed n-shell alkali spectra.** Ellis, D.G.; Curtis, L.J. (Univ. of Toledo, OH). *Nuclear Instruments and Methods;* **202**: 339-340(1982). Contract AS05-80ER10676.

Term values and ionization potentials have been calculated for several ions in the promethium (N = 61) isoelectronic sequence. As the nuclear charge is increased, the ground configuration changes from $4f^{13}5s^2$ to $4f^{14}5s$ giving the upper portion of the sequence an alkali-like character. According to their most recent Hartree-Fock calculations with first-order relativistic corrections, the ground term is 5s ^2S for $Z > 77$ (Ir XVII) and the first excited term is 5p $^2P^0$ for $Z > 84$ (P_0 XXIV). Comparisons are made with calculations of Cowan in W XIV. The prospects for observation of these spectra in fast ion beams are discussed. 8 references, 1 figure, 1 table.

26109 **Search for promethium-like gold lines and other transitions of interest to fusion research.** Johnson, B.M.; Jones, K.W.; Kruse, T.H.; Curtis, L.J.; Ellis, D.G. (Brookhaven National Lab., Upton, NY). *Nuclear Instruments and Methods;* **202**: 53-58(1982). Contract AS05-80ER10676;AC02-76CH00016.

EUV spectra in the range $\lambda = 13\text{-}40$ nm were measured for foil-excited gold ions at 31-238 MeV. Data were recorded at the higher energies to extend and to complement previous measurements and at the lowest energy to see if the recently predicted 5s-5p resonance lines in the Pm-like ion, Au XIX, could be seen in beam-foil excitation. The experimental results are presented, previous beam-foil measurements are reviewed, and the contributions and relations to fusion research are discussed. 2 figures.

26110 **Semiclassical parameterization of the $l \geqq 3$ energy levels in Cs I.** Curtis, L.J.; Ramanujam, P.S. (Univ. of Toledo, OH). *Journal of the Optical Society of America;* **71**: No. 11, 1315-1317(Nov 1981). Contract AS05-80ER10676.

A simple semiclassical model is used to describe the $l \geqq 3$ term energies in Cs I. The passive electrons are treated as a thin hollow shell of charge that can be polarized and penetrated by an active electron in a quantized Kepler orbit. The data are parameterized by weighted nonlinear least-squares adjustment of effective values for the dipole and quadrupole polarizabilities, the core radius, and the penetrated charge. The formulation represents the data well, permits predictive extrapolations, and provides intuitive insights into penetration effects. It is shown that apparent differences in the effective quadrupole polarizabilities inferred from the f and g series are removed when penetration effects are included. 14 references, 1 table.

26111 **Semi-empirical regularities in the spectra and transition probabilities of heavy and high ionized atoms.** Curtis, L.J. (Univ. of Toledo, OH). *Nuclear Instruments and Methods;* **202**: 333-338(1981). Contract AS05-80ER10676.

Semi-empirical methods are being used to systemize available data for one and two valence electron isoelectronic sequences to provide accurate estimates of energy levels, fine structure separations, transition probabilities, ionization potentials, etc. in very heavy and very highly ionized atoms. Through core polarization and core penetration models, quantum defect formulations and charge screening parameterizations, quantifiable regularities have been discovered which can be tested for higher ionization stages by fast ion beam methods. The techniques are described and several applications are presented. 32 references, 3 figures, 1 table.

26112 **Semiclassical formula for the term energy of a many-electron atom.** Curtis, L.J. (Univ. of Toledo, OH). *Journal of Physics B: Atomic and Molecular Physics;* **14**: 1373-1386(1981). Contract AS05-80ER10676.

A semiclassical formulation for the term energy of a many-electron atom is presented which includes gross structure, fine structure, core polarization and core penetration effects. A very simple model combining perturbed Keplerian orbits with the Bohr-Sommerfeld-Wilson quantization hypothesis yields an explicit formula which, in appropriate limits, reduces to the familiar core polarizability and quantum defect parameterizations. The formula also provides a new parametrization in terms of an effective core charge within an effective core radius, which has been applied to predict higher term values in the 3sng states of Si III. 22 references, 2 figures, 3 tables.

26113 **Semi-empirical calculations of fine structure splittings and ionization potentials in the MgI isoelectronic sequence.** Curtis, L.J.; Ramanujam, P.S. (Univ. of Toledo, OH). *Physica Scripta;* **23**: 1043-1046(1981). Contract AS05-80ER10676.

A semi-empirical parameterization of the singlet-triplet and fine structure splittings for available measurements of the 3s3p /sup 1,3/P levels in the MgI isoelectronic sequence has revealed regularities which are useful for interpolation and extrapolation. By combining an extrapolation of the empirical gross energies, Slater integrals and spin-orbit splitting factors to highly ionized members of this sequence with available measurements for the $3s^2$ ^1S-3s3p ^1P transitions, the positions of the members of the 3s3p ^3P multiplets and the ionization potentials can be predicted. 30 references, 4 figures, 3 tables.

26114 **Cross sections for inelastic scattering of electrons by atoms - selected topics related to electron microscopy.** Inokuti, M.; Manson, S.T. (Argonne National Lab., IL). pp 1-17 of Electron beam interactions with solids. Chicago, IL; SEM, Inc. ([1987]).

The authors begin with a resume of the Bethe theory, which provides a general framework for discussing the inelastic scattering of fast electrons and leads to powerful criteria for judging the reliability of cross-section data. The central notion of the theory is the generalized oscillator strength as a function of both the energy transfer and the momentum transfer, and is the only non-trivial factor in the inelastic-scattering cross section. Although the Bethe theory was initially conceived for free atoms, its basic ideas apply to solids, with suitable generalizations; in this respect, the notion of the dielectric response function is the most fundamental. Topics selected for discussion include the generalized oscillator strengths for the K-shell and L-shell ionization for all atoms with $Z \leqq 30$, evaluated by use of the Hartree-Slater potential. As a function of the energy transfer, the generalized oscillator strength most often shows a non-monotonic structure near the K-shell and L-shell thresholds, which has been interpreted as manifestations of electron-wave propagation through atomic fields. For molecules and solids, there are additional structures due to the scattering of ejected electrons by the fields of other atoms. 56 references, 18 figures.

6404 Fluid Physics

REFER ALSO TO CITATION(S) 24862, 26066, 26247

26115 **(DOE/ER/45131—4) Physics of pattern formation at liquid interfaces: Final report for the period August 1984-December 1986.** Maher, J.V. (Pittsburgh Univ., PA (USA)). 1987. Contract FG02-84ER45131. 37p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007540.

Viscous fingering experiments have been performed in both flat and circular interface geometries. The interest has been to study the early stages of the flow from the linear regime on through to the non-linear pattern formation.

26116 **(PB—87-143178/XAB) Pierce instability and bifurcating equilibria.** Godfrey, B.B. (Mission Research Corp., Albuquerque, NM (USA)). 2 Apr 1981. 21p. (AMRC-R—282). NTIS, PC A02/MF A01.

The report investigates the connection between equilibrium bifurcations and occurrence of the Pierce instability. Electrons flowing from one ground plane to a second through an ion background possess a countable infinity of static equilibria, of which only one is uniform and force-free. Degeneracy of the uniform and simplest non-uniform equilibria at a certain ground plan separation marks the onset of the Pierce instability, based on a newly derived dispersion relation appropriate to all the equilibria. For large ground plane separations the uniform equilibrium is unstable and the non-uniform equilibrium is stable, the reverse of their stability properties at small separations. Onset of the Pierce instability at the first bifurcation of equilibria persists in more complicated geometries, providing a general criterion for marginal stability. It seems probable that bifurcation analysis can be a useful tool in the overall study of stable beam generation in diodes and transport in finite cavities.

26117 **(SAND—86-2281C) Onset of Taylor vortices in flows with a circumferential pressure gradient: application to the helical screw rheometer.** Bixler, N.E.; Kraynik, A.M. (Sandia National Labs., Albuquerque, NM (USA). Fluid and Thermal Sciences Dept.). 1987. Contract AC04-76DP00789. 6p. (CONF-870533—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000453.

From 11. Canadian congress of applied mechanics; Edmonton, Canada (31 May 1987).

Taylor vortex flows are analyzed for the stability of flow between two rotating, concentric cylinders. The study is pertinent to the helical screw rheometer. Relative stability is given for four configurations: (1) high pressure, (2) chemically reacting fluids, (3) multiphase fluids, and (4) on-line measurements. (WRF)

26118 **Foam rheology: a model of viscous phenomena.** Kraynik, A.M.; Hansen, M.G. (Fluid and Thermal Sciences Department, Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Rheology;* **31**: No. 2, 175-205(Feb 1987). Contract AC04-76DP00789.

A theoretical model for foam rheology that includes viscous forces is developed by considering the deformation of two-dimensional, spatially periodic cells in simple shearing and planar extensional flow. The undeformed hexagonal cells are separated by thin liquid films. Plateau border curvature and liquid drainage between films is neglected. Interfacial tension and viscous tractions due to stretching lamellar liquid determine the individual film tensions. The network motion is described by a system of nonlinear ordinary differential equations for which numerical solutions are obtained. Coalescense and disproportionation of Plateau borders results in the relative separation of cells and provides a mechanism for yielding and flow. This process is assumed to occur when a film's length reduces to its thickness. The time and position dependence of the cell-scale dynamics are computed explicitly. The effective continuum stress of the foam is described by instantaneous and time-averaged quantities. The capillary number, a dimensionless deformation rate, represents the relative importance of viscous and surface tension effects. The small-capillary-number or quasistatic response determines a yield stress. The dependence of the shear and normal stress material functions upon deformation rate, foam structure and physical properties is determined. A plausible mechanism for shear-induced material failure, which would determine a shear strength, is revealed for large capillary numbers. The mechanism involves large cell distortion and film thinning, which provide favorable conditions for film rupture.

26119 **Fractal behavior of single-particle trajectories and isosets in isotropic and anisotropic fluids.** Kalia, R.K.; de Leeuw, S.W.; Vashishta, P. (Argonne National Lab., Argonne, IL). pp 285-290 of Condensed matter theories: Vol. 1. Malik, F.B. New York, NY; Plenum Press (1986). (CONF-8508135—).

From 9. international workshop on condensed matter theories; San Francisco, CA, USA (5 Aug 1985).

Fractal behavior associated with single-particle trajectories and isosets is observed in molecular dynamics simulations of liquids and superionic conductors. Fractal dimensions of trails and isosets are found to be 2 and 0.5, respectively. These values are shown to be universal in that they are independent of the spatial dimensionality, the nature of the interparticle interaction, and the thermodynamic state of the system. The single-particle motion in liquids is conventionally characterized by the velocity autocorrelation function and diffusion constant. These characteristics vary from system to system and are also functions of the thermodynamic state of the system. However, certain features of the single-particle motion are independent of the nature of the interaction or the thermodynamic state of the system. These universal features are manifested in the fractal behavior of single-particle trajectories and isosets: their fractal dimensions are always 2 and 0.5, respectively.

26120 **Variational density matrix theory I.** Campbell, C.E.; Kurten, K.E.; Ristig, M.L.; Senger, G. (Univ. of Minnesota, Minneapolis, MN). pp 153-158 of Condensed matter theories: Vol. 1. Malik, F.B. New York, NY; Plenum Press (1986). (CONF-8508135—).

From 9. international workshop on condensed matter theories; San Francisco, CA, USA (5 Aug 1985).

By replacing the wave function by the coordinate space representation of the N-body density matrix, where N is the number of particles in the system, a generalization to finite temperatures of the Jastrow-Euler-Lagrange variational theory of the ground state of quantum fluids is achieved. Schematically, the Bloch equation for the density matrix may be replaced by an Euler-Lagrange equation in which the trial density satisfies the properties described. The authors have taken the simplest non-trivial choice for two many-body functions, whereby the factors of the trial density have the Jastrow form and the incoherence factor has a similar two-body structure. Because the simple trial density matrix cannot achieve the correct high temperature limit the separability approximation is restrictive, limiting the validity of the numerical results to low temperatures.

26121 **Sound scattering by a group of oscillatory cylinders.** Lin, W.H.; Raptis, A.C. (Argonne National Lab., IL). *Journal of the Acoustical Society of America;* **77**: No. 1, 15-28(Jan 1985).

This paper is mainly concerned with an analytical study of multiple scattering of a plane sound wave by a group of circular, rigid cylinders oscillating in an ideal fluid. The objectives of the study are to investigate the phenomenon of multiple scattering due to the presence and the movement of many scatterers' oscillations on the associated scattering functions. The fluid medium is assumed inviscid and compressible and the solid cylinders are assumed to move freely under the action of the sound waves. The acoustical radiation field caused by the translatory oscillations of the cylinders was taken into account for the correction to the main scattering caused by the mere presence of the rigid cylinders. 20 references, 17 figures.

26122 Mathematical physics: relativistic magnetohydrodynamics as a Hamiltonian system. Holm, D.D.; Kupershmidt, B.A. (Los Alamos National Lab., NM). *Comptes Rendus de l'Academie des Sciences, Serie 1: Mathematique;* **300**: No. 5, 153-156(1985).

The equations of ideal relativistic magnetohydrodynamics in the laboratory frame form a noncanonical Hamiltonian system with the same Poisson bracket as for the nonrelativistic system, but with dynamical variables and Hamiltonian obtained via a regular deformation of their nonrelativistic counterparts. 6 references.

6450 High Energy Physics

REFER ALSO TO CITATION(S) 26380

26123 Techniques and concepts of high-energy physics III. Ferbel, T. New York, NY; Plenum Press (1985). 436p. (CONF-8408160—). Plenum Publishing Corp., New York, NY.

From NATO advanced study institute on techniques and concepts of high energy physics; St. Croix, VI, USA (2 Aug 1984).

This book presents information regarding tests and present astatus of gauge theories, cosmology and particle physics, calorimetry in high energy physics, and neutrino masses and mixings. New acceleration methods, e^+e^- colliders, unification and supersymmetry and topics in the physics of particle accelerators are also discussed.

6451 Particle Interactions And Properties - Experimental

26124 (DOE/ER/03072—T10) Princeton University high energy physics: Research highlights, August 1, 1986-January 31, 1987. (Princeton Univ., NJ (USA)). 24 Feb 1987. Contract AC02-76ER03072. 8p. NTIS, PC A02. File Number DE87006430.

Progress is reported in the study of CP violation in the neutral kaon system, search for $K^+ \rightarrow \pi^+$ + missing neutrals, forward production of muon pairs, nonlinear quantum electrodynamics, search for short-range gravitational forces, and various theoretical topics involving string theory, QCD, and electroweak processes. (LEW)

26125 (DOE/ER/70285—T1) Intercampus Institute for Research at Particle Accelerators: Annual progress report, January 1, 1980-June 1982. Ko, W.; Lander, R.L.; Pellett, D.E.; Williams, M.C.S.; Eisner, A.M.; Masek, G.E.; Miller, E.; Sullivan M.; Vernon, W.; Caldwell, D.O. (California Univ., Davis (USA); California Univ., San Diego (USA); California Univ., Santa Barbara (USA)). Oct 1982. Contract AS03-76ER70285. 93p. NTIS, PC A05. File Number DE87006296.

Progress on the PEP-9 experiment, which observes two-photon processes, is described. The experiment's collaborators are listed, along with individual group responsibilities, and the major components of the experimental apparatus are described briefly. The physics objectives of the experiment are reviewed with reference to recent experimental results. The effect of the reconfiguration of PEP interaction regions on the PEP-9 experiment are considered. Also discussed are the calibration and resolution of the NaI arrays, muon drift chamber tests and performance, shower counter performance, and the current resolution of the TOF elements. Some preliminary results from the PEP-9 experiment are given, including a first look at single tag $\pi^+\pi^+$ production. (LEW)

26126 (FNAL/C—87/22) Software for the ACP [Advanced Computer Program] multiprocessor system. Biel, J.; Areti, H.; Atac, R.; Cook, A.; Fischler, M.; Gaines, I.; Kaliher, C.; Hance, R.; Husby, D.; Nash, T. (Fermi National Accelerator Lab., Batavia, IL (USA)). 2 Feb 1987. Contract AC02-76CH03000. 9p. (CONF-870249—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006415.

From Computing high energy physics; Pacific Grove, CA, USA (2 Feb 1987).

Software has been developed for use with the Fermilab Advanced Computer Program (ACP) multiprocessor system. The software was designed to make a system of a hundred independent node processors as easy to use as a single, powerful CPU. Subroutines have been developed by which a user's host program can send data to and get results from the program running in each of his ACP node processors. Utility programs make it easy to compile and link host and node programs, to debug a node program on an ACP development system, and to submit a debugged program to an ACP production system.

26127 (LA—10937-T) A search for the rare decay $\mu i \rightarrow e^+\gamma\gamma$. Grosnick, D.P. (Los Alamos National Lab., NM (USA)). Feb 1987. Contract W-7405-ENG-36. 224p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87007721.

An experimental search for the lepton-family number nonconserving decay, $\mu^+ \rightarrow e^+\gamma\gamma$, has been conducted at the Clinton P. Anderson Meson Physics Facility (LAMPF) using the Crystal Box detector. The detector consists of a modular NaI(Tl) calorimeter, scintillator hodoscope, and a high-resolution, cylindrical drift chamber. It provides a large solid-angle for detecting three-body decays and has good resolutions in the time, position, and energy measurements to eliminate unwanted backgrounds. No evidence for $\mu^+ \rightarrow e^+\gamma\gamma$ is found, giving an upper limit for the branching ratio of $\Gamma(\mu \rightarrow e\gamma\gamma)/\Gamma(\mu \rightarrow$ e nu anti nu) $\leqq 7.2 \times 10^{-11}$ (90% C.L.). This result is an improvement of more than two orders of magnitude in the existing limit. 109 refs., 39 figs.

26128 (LBL—22883) Data management for high energy physics experiments: Preliminary proposals. Olken, F.; Loken, S.C.; Rotem, D.; Shoshani, A.; Trippe, T.G. (Lawrence Berkeley Lab., CA (USA)). Jan 1987. Contract AC03-76SF00098. 9p. (CONF-870249—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006940.

From Computing high energy physics; Pacific Grove, CA, USA (2 Feb 1987).

Currently HEP experimental data are reduced as they become available. We propose instead a "demand driven" approach to data analysis. Full analysis will be performed only as needed, in response to user queries which specify the subset of events for which reduced data is needed. To support this approach we propose to partition the datasets on the cross product of several trigger inputs, instead of storing the data in chronological order. Queries will be automatically decomposed into a set of requests against several partitions. Indexing, physically clustering the data on the logical partitions, and caching of partitions will be employed for efficiency.

26129 (SLAC-PUB—3972) The strange meson resonances observed in the reaction $K^- p \rightarrow$ anti $K^0\pi^+\pi^- n$ at 11 GeV/c. Aston, D.; Awaji, N.; D'Amore, J.; Dunwoodie, W.; Endorf, R.; Fujii, K.; Hayashii, H.; Iwata, S.; Johnson, W.B.; Kajikawa, R. (Stanford Linear Accelerator Center, Menlo Park, CA (USA); Nagoya Univ. (Japan). Dept. of Physics; Cincinnati Univ., OH (USA). Dept. of Physics; Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). May 1986. Contract AC03-76SF00515. 19p. (CONF-860701—80). NTIS, PC A02. File Number DE87006583.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

A model incorporating K^* resonance contributions and simple backgrounds is shown to quantitatively reproduce the mass dependence of the partial wave amplitudes governing the production and decay of the anti $K^0\pi^+\pi^-$ system. A fit of this model to these amplitudes confirms the resonance interpretations of the well-established 1^+ $K_1(1400)$, the 2^+ $K_2^*(1430)$, the 3^- $K_3^*(1780)$, and the less well-known 1^- states, the $K^*(1410)$ and the $K^*(1790)$. The 4^+ amplitudes are shown to be consistent with the production and decay of the 4^+ $K_4^*(2060)$. A second 2^+ enhancement at a mass of ~ 1.95 GeV/c^2 can be interpreted as resonant and may be the radial excitation of the $K_2^*(1430)$ or the triplet partner of the $K_4^*(2060)$. New measurements of the masses, widths and branching ratios of these states are given, and the implications of these data for the spectroscopy of the nonstrange meson sector are discussed.

26130 (SLAC-PUB—4239) Study of the baryon - antibaryon decays of the J/psi. Baltrusaitus, R.M.; Coffman, D.; Dubois, G.; Eigen, G.; Hauser, J.; Hitlin, D.G.; Matthews, C.G.; Russell, J.J.; Zhu, Y.; Dorfan, D.E. (Stanford Linear Accelerator Center, Menlo Park, CA (USA); California Inst. of Tech., Pasadena (USA); California Univ., Santa Cruz (USA); Illinois Univ., Urbana (USA); Washington Univ., Seattle (USA)). Feb 1987. Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050. 20p. (CONF-860701—75). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006780.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

The Mark III collaboration presents results on the decays J/psi → B_8 anti B_8, and J/psi → B_8 anti B_{10} using 5.8 x 10^6 produced J/psi's collected at SPEAR. Branching ratios have been determined for the decays J/psi → Σ^+ anti Σ^- (1385) + c.c., J/psi → Ξ^- anti Ξ^+ (1530) + c.c. and J/psi → Ξ^- anti Ξ^+. An upper limit on the branching ratios for the decay J/psi → Ξ^0 anti Ξ^0 (1530) + c.c. has also been determined. These indicate large isospin violation in the decay patterns for J/psi → Ξ anti Ξ^*. 7 refs., 9 figs.

26131 (SLAC-PUB—4240) Observation of e^+e^- yield F^{*-+} at $\sqrt{8}$ = 4.14 GeV. Blaylock, G.T.; Bolton, T.; Brown, J.S.; Bunnell, K.O.; Burnett, T.H.; Cassell, R.E.; Coffman, D.; Cook, V.; Coward, D.H.; Dorfan, D.E. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Feb 1987. Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050. 16p. (CONF-860701—76). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006781.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

The Mark III collaboration at SPEAR observes charm-strange associated production in the reaction $e^+e^- \rightarrow F^{+-}F^{*-+}$ at $\sqrt{8}$ = 4.14 GeV. The F^{+-} is reconstructed in the phiπ^{+-} mode and the F^{*-+} is detected in the recoil mass distribution from the F^{+-}. The observed F mass is (1977.6 +- 4.3 (stat.) +- 4.0 (syst.)) MeV/c^2 and the F^* mass is (2106.8 +- 1.8 +- 6.2) MeV/c^2. The production rate at $\sqrt{8}$ = 4.14 GeV is $\sigma(e^+e^- \rightarrow F^{+-}F^{*-+})$. B(F^{+-} → phiπ^{+-}) = (36 +- 7 +- 13)pb. 12 refs., 6 figs.

26132 (SLAC-PUB—4241) Determination of the branching ratio tau → rho nu. Becker, J.J.; Blaylock, G.T.; Bolton, T.; Brown, J.S.; Bunnell, K.O.; Burnett, T.H.; Cassell, R.E.; Coffman, D.; Cook, V.; Coward, D.H. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Feb 1987. Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050. 12p. (CONF-860701—77). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006782.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

The decay tau → rho nu was studied in tau- pair production by e^+e^- annihilation at $\sqrt{s}$ = 3.77 GeV. The branching ratio was measured to be B(rho nu) = 22.3 +- 1.4 +- 1.6%. 5 refs., 2 figs.

26133 (SLAC-PUB—4242) Observation of the radiative decay J/psi → γ phi ω. Becker, J.J.; Blaylock, G.T.; Bolton, T.; Brown, J.S.; Bunnell, K.O.; Burnett, T.H.; Cassell, R.E.; Coffman, D.; Cook, V.; Coward, D.H. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Feb 1987. Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050. 11p. (CONF-860701—74). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006783.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

The MARK III Collaboration has studied the OZI violating radiative decay J/psi → γ phi ω, in order to complete the set of measured J/psi → γ vector vector decays. This channel is then used to search for a new decay mode of the ξ(2330) and to study the eta/sub c/ decay mechanism. The phi ω mass spectrum does not show any significant structure; upper limits for the excitation of the ξ and eta/sub c/ particles are obtained. 11 refs., 3 figs.

26134 (SLAC-PUB—4243) Recent results of hadronic decays of J/psi into vector-tensor from MARK III. Becker, J.J.; Blaylock, G.T.; Bolton, T.; Brown, J.S. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Feb 1987. Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050. 16p. (CONF-860701—79). NTIS, PC A02. File Number DE87006784.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

From a data sample of 5.8 x 10^6 J/psi's collected by the MARK III detector at the storage ring SPEAR at SLAC, two-body decay modes of the J/psi into a vector and a tensor meson have been measured. From the studies of the tensor meson, recoiling against the ideally mixed and well understood vector mesons, quark correlations are established and compared with the theoretical expectations of the J/psi decays and the SU(3) predictions. The beginnings of a similar systematic study of the two-body vector scalar decays are also presented.

26135 (SLAC-PUB—4244) Search for $D^+ \rightarrow \mu^+$ nu/sub mu/ decay, and the pseudoscalar decay constant f/sub D/. Becker, J.J.; Blaylock, G.T.; Bolton, T.; Brown, J.S.; Bunnell, K.O.; Burnett, T.H.; Cassell, R.E.; Coffman, D.; Cook, V.; Coward, D.H. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Feb 1987. Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050. 20p. (CONF-860701—78). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006785.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

Results of a search for the purely leptonic decay $D^+ \rightarrow \mu^+$ nu/sub μ/ using the Mark III detector at SPEAR are reported. No signal is observed in a data sample of 9.3 pb^{-1} collected at the psi(3770) resonance, where 1.2 +- 0.16 (stat.)/sub -0.20//sup +0.24/ background events are expected. The 90% CL upper limit on the branching ratio B($D^+ \rightarrow \mu^+$ nu/sub μ/) is found to be 8.4 x 10^{-4}, corresponding to an upper limit on f/sub D/ of 340 MeV/c^2. This limit has implications for the theoretical understanding of differences in D^0 and D^+ lifetimes, D^0 anti D^0 and B^0 anti B^0 mixing, and provides a test of the non-relativistic potential model. 20 refs., 3 figs.

26136 (SLAC-PUB—4245) Study of the K antiKπ final state in J/psi hadronic decays. Becker, J.J.; Blaylock, G.T.; Bolton, T.; Brown, J.S.; Bunnell, K.O.; Burnett, T.H.; Cassell, R.E.; Coffman, D.; Cook, V.; Coward, D.H. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Feb 1987. Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050. 14p. (CONF-860701—81). NTIS, PC A02. File Number DE87006786.

From 23. international conference on high-energy physics; Berkeley, CA, USA (16 Jul 1986).

The reactions J/psi → ωK antiKπ and J/psi → phiK^{+-}K/sub S/$^0\pi^{-+}$ have been studied using a sample of 5.8 x 10^6 produced J/psi decays. The K^{+-} K/sub S/$^0\pi^{-+}$ and $K^+K^-\pi^0$ systems recoiling against an ω show enhancements in the mass distribution around 1.445 GeV/c^2 with consistent branching ratios. No such structure is observed in the mass distribution of the K^{+-} K/sub S/$^0\pi^{-+}$ system recoiling against a phi. A comparison of these observations with the corresponding channels in radiative J/psi decays permits a detailed study of the structures seen in the iota(1440) and E(1420) signal regions. 8 refs., 4 figs.

26137 Searches for supermassive X^- particles in iron. Norman, E.B.; Gazes, S.B.; Bennett, D.A. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review Letters;* **58**: No. 14, 1403-1406(6 Apr 1987). Contract AC03-76SF00098.

Two searches have been made for negatively charged massive elementary particles (X^-) in iron nuclei by utilizing the fact that such systems would have the nuclear properties of iron but the chemical properties of manganese. We have looked for /sup 56,58/ FeX^- by searching for γ rays emitted following the β decays of /sup 56/CoX^- and /sup 59/FeX^- produced by (p,n) and (n,γ) reactions, respectively. No evidence of such particles was observed in either experiment, and a limit has been established on the possible concentration of X^- particles in iron of <1.2 x 10/sup -12/ per nucleon.

26138 Multiplicity dependence of transverse momentum spectra in pp, anti pp, dd and $\alpha\alpha$ collisions at ISR energies. Breakstone, A.; Campanini, R.; Cuffiani, M.; Deninno, M.M.; Fabbri, F.; Giacomelli, G.; Mankel, R.; Rimondi, F.; Claesson, G.; Garpman, S. (Ames Lab., IA, USA; Hawaii Univ., Honolulu, USA. Dept. of Physics; Bologna Univ., Italy. Dipartimento di Fisica; Istituto Nazionale di Fisica Nucleare, Pisa, Italy). *Physics Letters [Section] B;* **183**: No. 2, 227-231(8 Jan 1987). Contract W-7405-ENG-82.

We analyse the variation of the average transverse momentum, <p/sub T/>, with the multiplicity of charged particles produced in pp, anti pp, dd and $\alpha\alpha$ collisions at ISR energies. An increase of <p/sub T/> with increasing particle density rho=ΔN/Δy for charged particles produced in the central region is observed. The energy dependence of this effect and its dependence on the type of colliding particles are discussed.

26139 Experimental study of the reactions $e^+e^- \rightarrow e^+e^-$ and $e^+e^- \rightarrow \gamma\gamma$ at 29 GeV. Derrick, M.; Gan, K.K.; Kooijman, P.; Loos, J.S.; Musgrave, B.; Price, L.E.; Schlereth, J.; Sugano, K.; Weiss, J.M.; Wood, D.E. (Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review [Section] D: Particles and Fields;* **34**: No. 11, 3286-3303(1 Dec 1986). Contract W-31-109-ENG-38.

This paper reports measurements of the differential cross sections for the reactions $e^+e^- \rightarrow e^+e^-$ (Bhabha scattering) and $e^+e^- \rightarrow \gamma\gamma$ (γ-pair production). The reactions are studied at a center-of-mass energy of 29 GeV and in the polar-angular region chemical bond costheta chemical bond <0.55. A direct cross-section comparison between these two reactions provides a sensitive test of the predictions of quantum electrodynamics (QED) to order α^3. When the ratio of γ-pair to Bhabha experimental cross sections, integrated over chemical bond costheta chemical bond <0.55, is divided by the same ratio predicted from α^3 QED theory, the result is 1.007 +- 0.009 +- 0.008. The 95%-confidence limits on the QED-cutoff parameters are Λ/sub +/>154 GeV and Λ/sub -/>220 GeV for Bhabha scattering, and Λ/sub +/>59 GeV and Λ/sub -/>59 GeV for γ-pair production.

26140 Study of noncollinear two-charged-particle events produced in 29-GeV electron-positron annihilation. Perl, M.L.; Mueller, L.; Barklow, T.; Boyarski, A.M.; Breidenbach, M.; Burchat, P.R.; Burke, D.L.; Dorfan, J.M.; Feldman, G.J.; Gladney, L. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Physical Review [Section] D: Particles and Fields;* **34**: No. 11, 3321-3331(1 Dec 1986). Contract AC03-76SF00515;AC03-76SF00098;AC02-76ER03064.

This paper presents a study of events produced in 29-GeV electron-positron annihilation in which there are just two noncollinear charged particles, no detected photons, and two or more undetected particles. These events can be explained by attributing them primarily to the reactions $e^+e^- \rightarrow e^+e^-e^+e^-$ and $e^+e^- \rightarrow e^+e^-\mu^+\mu^-$ where just two particles appear in the Mark II detector. There is no evidence for unconventional sources for such events.

26141 Study of quark fragmentation in e^+e^- annihilation at 29 GeV: Charged-particle multiplicity and single-particle rapidity distributions. Derrick, M.; Gan, K.K.; Kooijman, P.; Loos, J.S.; Musgrave, B.; Price, L.E.; Repond, J.; Schlereth, J.; Sugano, K.; Weiss, J.M. (Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review [Section] D: Particles and Fields;* **34**: No. 11, 3304-3320(1 Dec 1986). Contract W-31-109-ENG-38;AC02-76ER01112;AC03-76SF00098;AC02-76ER01428.

This paper presents the charged-particle multiplicity distributions for e^+e^- annihilation at $\sqrt{s} = 29$ GeV measured in the High Resolution Spectrometer. The data, which correspond to an integrated luminosity of 185 pb/sup -1/, were obtained at the SLAC e^+e^- storage ring PEP. The techniques used to correct the observed prong numbers are discussed. The multiplicity distribution of the charged particles has a mean value <n> = 12.87 +- 0.03 +- 0.30, a dispersion D_2 = 3.67 +- 0.02 +- 0.18, and an f_2 moment of 0.60 +- 0.02 +- 0.18. Results are also presented for a two-jet sample selected with low sphericity and aplanarity. The charged-particle distributions are almost Poissonian and narrower than have been reported by other e^+e^- experiments in this energy range. The mean multiplicity increases with the event sphericity, and for the sample of threefold-symmetric three-jet events, a value of <n> = 16.3 +- 0.3 +- 0.7 is found. No correlation is observed between the multiplicities in the two hemispheres when the events are divided into two jets by a plane perpendicular to the thrust axis. This result is in contrast with the situation in soft hadronic collisions, where a strong forward-backward correlation is measured. For the single jets, a mean multiplicity of 6.43 +- 0.02 +- 0.15 and a dispersion value of D_2 = 2.55 +- 0.02 +- 0.13 are found. These values give further support to the idea of independent jet fragmentation. The multiplicity distributions are well fit by the negative-binomial distribution.

26142 Status of the glueballs. Lindenbaum, S.J. (Brookhaven National Lab., Upton, NY). pp 631-672 of How far we are from the gauge forces. Zichichi, A. New York, NY; Plenum Press (1985). (CONF-8308166—).

From 21. meeting of the International School of Subnuclear Physics; Erice, Italy (3 Aug 1983).

This paper shows that the BNL/CCNY g/sub T/ (2120), g/sub T/ ' (2220) and g/sub T/ " (2360) all with I/sup G/ J/sup PC/ = 0^+2^{++} observed in pion minus-proton to phi meson-phi meson-nucleon decay are produced by glueballs if: QCD is correct; and if the OZI rule is universal for weakly coupled glue in Zweig disconnected diagrams where the disconnection is due to the creation or annihilation of new quark flavors. Since the input axioims are in good agreement with experiments and merely represent modern QCD practice, the author feels that he has probably discovered 1-3 J/sup PC/ = 2^{++} glueballs. The iota (1440) and the /theta/(1700) observed in J//psi/ radiative decay are glueball candidates.

26143 High-energy photoproduction of charmed states. Holmes, S.D.; Lee, W.; Wiss, J.E. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Annual Review of Nuclear Science;* **35**: No. 1, 397-454(1985).

The photoproduction of Psi and D meson resonances is reviewed. The results are interpreted in terms of the vector dominance model. (AIP)

6452 Particle Interactions And Properties - Theoretical

REFER ALSO TO CITATION(S) 26124, 26164, 26174, 26175, 26176, 26179

26144 (DOE/ER/40160—3) High energy hadron-hadron collisions: Annual progress report. Chou, T.T. (Georgia Univ., Athens (USA). Dept. of Physics). Jan 1987. Contract FG09-84ER40160. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006732.

Results of a study on high energy particle production processes with the geometrical model are summarized. An analysis of the forward-backward charge distribution in anti pp collision leads to the suggestion that the distribution with respect to the charge asymmetry is binomial. With the introduction of the partition-temperature concept, a high energy hadron-hadron collision is described as an incoherent superposition of collisions with different partition temperatures. A concise formula for single particle momentum spectrum is obtained. Angular distributions are calculated and extrapolated to higher and lower energies. The ideas introduced for hadronic collisions are then applied to two-jet e^+e^- annihilation. This leads to a unified physical picture for both hadron-hadron and e^+e^- collisions and many predictions which can be tested. Further experiments are suggested. 31 refs.

26145 (SLAC-PUB—4223) Electroweak interaction: Standard and beyond. Harari, H. (Weizmann Inst. of Science, Rehovoth (Israel); Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Feb 1987. Contract AC03-76SF00515. 32p. (CONF-860736—10). NTIS MF A01; 2; GPO Dep. File Number DE87006779.

From SLAC summer institute on particle physics; Stanford, CA, USA (29 Jul 1986).

Several important topics within the standard model raise questions which are likely to be answered only by further theoretical understanding which goes beyond the standard model. In these lectures we present a discussion of some of these problems, including the quark masses and angles, the Higgs sector, neutrino masses, W and Z properties and possible deviations from a pointlike structure. 44 refs.

26146 **Partition temperature and energy conservation of particle production.** Hoang, T.F.; Cork, B. (Lawrence Berkeley Lab., CA, USA). *Zeitschrift fuer Physik [Sektion] C: Particles and Fields;* **34**: No. 3, 385-390(Apr 1987). Contract AC03-76SF00098.

The partition temperature estimated by Chou and Yang for e/sup +/e/sup -/ -> h/sup +-/ of TASSO experiment is compared with the cm average energy of the secondary h/sup +-/ using the Maxwellian P/sub perpendicular/ /sub to/ distribution of invariant phase-space. Fireball properties and secondary temperatures are investigated for e/sup +/e/sup -/ -> h/sup +-/, K/sup 0/anti K/sup 0/, Λanti Λ of the Mark II collaboration. The number of secondary particles is found to be equally divided among the central fireball and the other two of the fragmentation regions. Crucial tests based on energy conservation are carried out for temperature estimates for the Mark II data, and anti pp -> π at rest of the College de France-Cern experiment.

26147 **Ma responds.** Ma, E. (Department of Physics and Astronomy, University of Hawaii at Manoa, Honolulu, Hawaii 96822). *Physical Review Letters;* **58**: No. 13, 1381-1381(30 Mar 1987).

The author responds to comments concerning the phenomenology of his proposed model. (AIP)

26148 **Comment on a recent claim of calculable neutrino masses in superstring-inspired model.** Ma, E. (Department of Physics, University of California, Davis, California 95616 and Department of Physics and Astronomy, University of Hawaii at Manoa, Honolulu, Hawaii 96822). *Physical Review Letters;* **58**: No. 10, 1047-1047(9 Mar 1987).

A Comment on the Letter by A. Masiero, D. V. Nanopoulos, and A. I. Sanda, Phys. Rev. Lett. 57, 663 (1986).

26149 **Masiero, Nanopoulos, and Sanda respond.** Masiero, A.; Nanopoulos, D.V.; Sanda, A.I. (New York University, New York, New York 10003). *Physical Review Letters;* **58**: No. 10, 1048-1048(9 Mar 1987).

The authors comment on the effect of a discrete symmetry on their Dirac neutrino mass calculation. (AIP)

26150 **Asymmetries at e/sup +/e/sup -/ colliders for new quarks in E/sub 6/ theories.** Hewett, J.A.L.; Rizzo, T.G. (Ames Lab., IA, USA; Iowa State Univ. of Science and Technology, Ames, USA. Dept. of Physics). *Zeitschrift fuer Physik [Sektion] C: Particles and Fields;* **34**: No. 1, 49-55(Mar 1987). Contract W-7405-ENG-82.

We examine the forward-backward, left-right, and azimuthal asymmetries of quark pairs produced in e/sup +/e/sup -/ annihilation as a probe of possible new physics resulting from E/sub 6/ theories. The values of these asymmetries are compared for the production of E/sub 6/-exotic, mirror, and fourth generation quarks. Our results show that asymmetries provide an excellent method for distinguishing between these possible types of new quarks.

26151 **Nucleon-nucleon interactions and quarks I: General considerations with numerical results in the $^1S_0$ channel.** Hwang, W.h.P. (Nuclear Theory Center, Department of Physics, Indiana University, Bloomington, Indiana 47405). *Annals of Physics (New York);* **174**: No. 2, 247-298(Mar 1987).

In this paper, we discuss a general development of a quark-model description of nucleon-nucleon (NN) interactions, assuming that quarks are Dirac particles and nucleons are specified approximately by flavor SU(6) wave functions. The down (d) quark is differentiated from the up (u) quark allowing isospin symmetry violating effects. As a simple model calculation, we include effects due to one-gluon exchange (which dictates the short-range behavior of NN forces), one-pion exchange (which gives rise to the Yukawa tail in NN forces), single sigma-exchange (which mocks up to the intermediate attraction in an economical manner), and one-photon exchange (which contributes to isospin symmetry violations). To avoid introduction of additional shape parameters, we adopt a double-sphere geometry with an adjustable isolated nucleon radius. All quark-interchange effects are explicity evaluated and Pauli blocking is incorporated. Numerical results in the $^1S_0$ p-p, n-p, and n-n channels are described and discussed. In particular, it is found that the simple one-boson exchange model (at the quark level) provides a reasonable description of the $^1S_0$ phase shifts for 10 MeV≦T/sub C//sub M/≦150 MeV with T/sub C//sub M/ the center-of-mass [CM] kinetic energy.

26152 **On the squark and gluino mass limits from the CERN panti p collider.** Baer, H.; Karatas, D.; Tata, X. (Argonne National Lab., IL, USA. High Energy Physics Div.; Wisconsin Univ., Madison, USA. Dept. of Physics). *Physics Letters [Section] B;* **183**: No. 2, 220-226(8 Jan 1987). Contract W-31-109-ENG-38;AC02-76ER00881.

Recently announced lower limits on squark and gluino masses from CERN panti p collider data depend on three assumptions: (1) that the photino (γ tilde) is the lightest supersymmetric particle and escapes experimental detection, (2) that mγ tilde ≃ 0, and (3) that the five contributing flavors of right and left squars are mass degenerate. We examine the effect of relaxing these conditions on the quoted mass limits. We find the squark (gluino) mass limit virtually insensitive to increases in photino mass up to mγ tilde proportional to 30-40 GeV (20-30 GeV) if all jet + missing transverse energy (p/sub T/) events are taken into account. Furthermore, we quantify the effect of an unstable γ tilde scenario on both q tilde and g tilde mass limits. Finally we find that by relaxing the assumption of squark mass degeneracy, some squarks with masses as much as 10-15 GeV below quoted bounds may be compatible with the data.

26153 **Flux tube or bremsstrahlung?.** Niedermayer, F. (Department of Physics, University of California, La Jolla, California 92093). *Physical Review [Section] D: Particles and Fields;* **34**: No. 11, 3494-3498(1 Dec 1986).

The classical problem of radiation emitted by an accelerated charge is considered. We use the analogy to suggest that the space-time development of the bremsstrahlung which accompanies the color exchange in hadron-hadron inelastic scattering is very similar to that of the color flux-tube model. The bremsstrahlung yields a considerable contribution to the effective string tension. It is argued that one should distinguish between the string tension measured in static and dynamic processes.

26154 **On the electromagnetic contribution to inclusive production in proton-air collisions in the regime of projectile fragmentation.** Astur, R.; Ferbel, T. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Physical Review [Section] D: Particles and Fields;* **34**: No. 11, 3514-3515(1 Dec 1986).

We calculate the inclusive charged-particle differential cross section in p-/sup 14/N collisions expected on the basis of the inelastic p-/sup 14/N electromagnetic interaction at high energy.

26155 **Neutrino oscillations in nonuniform matter.** Halprin, A. (Physics Department, University of Delaware, Newark, Delaware 19716). *Physical Review [Section] D: Particles and Fields;* **34**: No. 11, 3462-3466(1 Dec 1986).

We examine the effect of flavor-dependent elastic scattering upon neutrino flavor vacuum oscillations. The results are derived from a first-principles Dirac equation for the phenomenon. The conjecture of Wolfenstein is validated (with a correction G→ √2 G as noted in more recent literature) for a homogeneous medium. While the differential equation obtained for the extension to a nonhomogeneous case appears to differ significantly from that which has been used in the literature heretofore, we are able to show that they are equivalent for densities that vary little over the neutrino's de Broglie wavelength.

26156 **Order-α/sub s/ QCD effects in technipion production and decay.** McKay, D.W.; Young, B.; Slaven, D. (The University of Kansas, Lawrence, Kansas 66045; Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510). *Physical Review* [*Section*] *D: Particles and Fields;* **34**: No. 11, 3394-3398(1 Dec 1986). Contract W-7405-ENG-48;FG02-85ER40214.

The three-body final-state decay modes of the technipion $P^{0\prime}$ which contribute as order-α/sub s/ corrections to two-body modes are calculated. The three-body modes are large, and the three-gluon final state is the dominant mode for M/sub P//sub <0/'$>35 GeV. Related effects in large-p/sub perpendicular/ production of $P^{0\prime}$ in p-p collisions are calculated, and the cross section at y = 0 is found to be comparable to those of W/sup +- / and Z production at Superconducting Super Collider energies but much smaller at Fermilab Tevatron energies. It is pointed out that similar results should be expected for scalars in other models, such as the standard Higgs or compositeness models.

26157 **Universal scattering theorems for strongly interacting W's and Z's.** Chanowitz, M.; Golden, M.; Georgi, H. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review Letters;* **57**: No. 19, 2344-2347(10 Nov 1986). Contract AC03-76SF00098.

The experimentally verified relationship M/sub W/ = M/sub Z/ costheta/sub W/ implies universal low-energy theorems for scattering of longitudinally polarized W and Z bosons provided that the symmetry-breaking sector contains no particles much lighter than 1 TeV.

26158 **Skyrmions in nuclear physics.** Meissner, U.G.; Zahed, I. (Univ. of Regensberg, Regensberg). pp 143-221 of Advances in nuclear physics. Vol. 17. Negele, J.W.; Vogt, E. New York, NY; Plenum Press (1986).

This paper reviews the essential aspects of the large N /sub c/ expansion, stressing the semiclassical character of QCD at low energy. The phenomenol aspects of chiral symmetry is discussed which leads to a description of the nonlinear model. The relative aspects of the Skyrme model are introduced and the salient properties of hedgehog solitons are discussed. Witten's reanalysis of the Wess-Zumino term in the general context of current algebra is presented. The authors show how the nucleon and delta isobar can be extracted from the hedgehog configuration. A detailed analysis of present day calculations on the baryon spectrum is presented. Relevant calculations on the twoand three- nucleon interactions in the Skyrme model are shown with a critical analysis of the major assumptions involved. Preliminary results on the deuteron based on a trial ansatz is presented.

26159 **Developments in quark models and relativistic nuclear physics.** Picklesimer, A. (Los Alamos National Lab., Los Alamos, NM). pp 453-460 of Antinucleon- and nucleon-nucleus interactions. Walker, C.E.; Goodman, C.E.; Olmer, C. New York, NY; Plenum Press (1985). (CONF-850315—).

From Conference on antinucleon and nucleon-nucleus interactions; Telluride, CO, USA (18 Mar 1985).

The author discusses nonrelativistic potential theory; relativisitic Dirac equation; scattering and bound states; Meson exchange models; quark substructure and models; and many-body interactions. He feels that what is sorely needed in individual research efforts within the context of each of the dynamical approaches is: precise specification of explicit assumption, precise statement of implicit assumptions, and sharp statements of truncations and approximations. Theoretical error bars on the results which arise from as many of the uncertainties as possible are also necessary.

26160 **Conference summary.** Wilets, L. (Univ. of Washington, Seattle, WA). pp 483-494 of Antinucleon- and nucleon-nucleus interactions. Walker, C.E.; Goodman, C.E.; Olmer, C. New York, NY; Plenum Press (1985). (CONF-850315—).

From Conference on antinucleon and nucleon-nucleus interactions; Telluride, CO, USA (18 Mar 1985).

The author summarizes the following topics of this conference: smoking guns; hadronic substructure; antinucleons; the EMC effect and relativity; and the Dirac Equation. He discusses the relativistic Lagrangian field theories for N-N interactions and nuclear matter. Nuclear matter and absence of correlations are described. The work on the missing Gamow-Teller strengths is mentioned.

26161 **Composite W-bosons and their dynamics.** Fritzsch, H. (Max Planck Institut for Physik, Munich). pp 293-324 of How far are we from the gauge forces. Zichichi, A. New York, NY; Plenum Press (1985). (CONF-8308166—).

From 21. meeting of the International School of Subnuclear Physics; Erice, Italy (3 Aug 1983).

This paper describes weak bosons as bound states. Their properties are approximately described within the standard SU(2) x U(1) theory. Small deviations from predictions made using this theory for certain physical quantities as well as the discovery of new effects like unusual decays of W and Z might soon reveal the composite nature of the W and Z- particle as well as of the leptons and quarks. The inverse size of the W-boson is expected to be in the range 0.1...1 TeV.

26162 **Inclusive decay of heavy flavours.** Altarelli, G. (CERN, Geneva). pp 325-350 of How far are we from the gauge forces. Zichichi, A. New York, NY; Plenum Press (1985). (CONF-8308166—).

From 21. meeting of the International School of Subnuclear Physics; Erice, Italy (3 Aug 1983).

The study of weak decays of heavy flavored particles is important as a source of information on many interesting aspects of the SU(3) - SU(2) - U(1) standard theory. The inclusive (semileptonic and total) decay rates are especially important in that they are the simplest and imply the least amount of model dependency. Many interesting problems are already met at this level and the author concentrates on inclusive rates in this paper. It is observed that the experimental verification of the prediction for the semileptonic branching ratio of D^+, B /sub s1/ (D^+) = ca 15%, would be a striking confirmation of the QCD enhancement factor for nonleptonic rates arising from short-distance effects.

6453 Particle Invariance Principles And Symmetries

REFER ALSO TO CITATION(S) 26055, 26177

26163 **Fixed-angle asymptotic behavior of the type-I superstring amplitude.** Clavelli, L.; Coulter, P.; Jones, S.T.; Lin, Z.h. (Department of Physics and Astronomy, The University of Alabama, Tuscaloosa, Alabama 35487). *Physical Review* [*Section*] *D: Particles and Fields;* **35**: No. 8, 2462-2465(15 Apr 1987).

The asymptotic limit of the four-point function at fixed angle is analyzed in the context of type-I superstrings. The analysis shows the amplitude to fall exponentially in s, at least at the one-loop level. This rate of decrease is faster than that which is allowed by the asymptotic theorem of Cerulus and Martin, but is consistent with the bound of Chiu and Tan.

26164 **Parity violation in the nucleon-nucleon interaction.** Adelberger, E.G.; Haxton, W.C. (Department of Physics, University of Washington, Seattle, Washington 98195). *Annual Review of Nuclear Science;* **35**: No. 1, 501-558(1985).

Parity nonconservation is studied in the standard model of elementary particles and in nuclear physics. Meson—nucleon couplings are discussed and A = 18 nuclei are considered in detail. Analyzing power measurements are reviewed. (AIP)

6454 Field Theory

REFER ALSO TO CITATION(S) 26142, 26156, 26163, 26228, 26240, 26252, 26260, 26261, 26262

26165 **(FNAL/Pub—87/25-A) Vacuum energy of M^4 x S/sup M/ x S/sup N/ in even dimensions.** Gleiser, M.; Jetzer, P.; Rubin, M.A. (Fermi National Accelerator Lab., Batavia, IL (USA); Rockefeller Univ., New York (USA). Dept. of Physics; Geneva Univ. (Switzerland). Dept. de Physique Theorique). Jan 1987. Contract AC02-76CH03000. 32p. (RU—87/B1/189). NTIS, PC A03. File Number DE87007046.

We obtain an expression for the one loop effective potential coming from quantum fluctuations of scalars and spin-1/2 fermions in a higher-dimensional manifold of product form M^4 x S/sup M/ x S/sup N/. In contrast to previous calculations, we consider the case in which the total number of dimensions is even, since this is the relevant case for superstring compactification. A detailed calculation for a ten-dimensional spacetime with two internal 3-spheres is performed, and an approximate static solution for the geometry is found, with the two internal radii being of the order of the Planck length for a sufficiently large number of matter fields. We study the stability of this solution and make some remarks on the possible cosmological implications of our results.

26166 **Four-dimensional boson field theory. III. Nontriviality.** Baker G.A. Jr.; Johnson, J.D. (Theoretical Division, Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545). *Journal of Mathematical Physics (New York);* **28**: No. 5, 1146-1158(May 1987). Contract W-7405-ENG-36.

The results of numerical investigations based on series analysis indicate clearly that the method of phantom fields constructs nontrivial, self-interacting scalar Euclidean boson field theories. It is found that these continuum theories arise as the scaling limit to normal critical points of lattice statistical mechanical models. The character of these theories is numerically indistinguishable from that of a classical theory on the lambda line near the tricritical point.

26167 **Even and odd critical exponents of lattice QED.** Lang, C.B.; Rebbi, C. (Institut fuer Theoretische Physik, Universitat Graz, A-8010 Graz, Austria). *Physical Review [Section] D: Particles and Fields;* **35**: No. 8, 2510-2517(15 Apr 1987).

The theory is simulated for Villain's action on 16^4 lattices. Block-spin transformations of two different types to 8^4, 4^4, and 2^4 are performed. We estimate the leading even and odd critical exponents and discuss the fixed-point structure of the theory.

26168 **Extended quantum kinematics as an origin of internal symmetries and flavors.** Yamada, K. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Physical Review [Section] D: Particles and Fields;* **35**: No. 8, 2559-2566(15 Apr 1987).

We present a kinematical framework for internal symmetries which is based on the hypothesis that, apart from gauge symmetries, the internal symmetries are discrete. The kinematical basis for the system with such a symmetry is given by extended commutation relations (ECR's). The hierarchy of internal symmetries emerges as one extends elementary group algebras step by step following ECR's. Possible groups of internal symmetries are then restricted to finite solvable groups. Yet they exhibit unexpectedly rich structures. We tentatively identify the origin of flavors, the number of which turns out to be infinite.

26169 **Perturbative stability of smooth strings.** Pisarski, R.D. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Physical Review Letters;* **58**: No. 13, 1300-1303(30 Mar 1987).

Polyakov's theory of surfaces embedded in Euclidean spacetime with an extrinsic curvature term is stable under small fluctuations only if the number of dimensions is positive and less than 26.

26170 **Noncommutative geometry model for closed bosonic strings.** Sen, S.; Holman, R. (School of Mathematics, Trinity College, Dublin 2, Ireland). *Physical Review Letters;* **58**: No. 13, 1304-1307(30 Mar 1987).

We show how Witten's noncommutative geometry may be extended to describe the closed bosonic string. An explicit representation of the contour-integral and * product for closed strings is provided.

26171 **Photon sector of quantum electrodynamics at high temperature in two spatial dimensions.** Alvarez-Estrada, R.F. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Annals of Physics (New York);* **174**: No. 2, 442-462(Mar 1987). Contract AC03-76SF00098.

The photon sector of quantum electrodynamics (QED) in two spatial dimensions is analyzed at high temperature to all orders of perturbation theory. Imaginary-time formalism is used. The photon self-energy and propagator at finite temperature with vanishing frequency is calculated to the second order of perturbation theory. Based upon the latter, an improved perturbation theory which incorporated Debye screening is formulated. By virtue of the latter and gauge invariance, infrared finitness holds. The temperature dependence of any contribution to the connected Green's functions in the improved perturbation theory is analyzed systematically. At very high temperature, the photon sector becomes equivalent to a very massive scalar boson field plus a massless electromagnetic field and both become decoupled: all connected Green's functions containing, at least, one closed fermion loop with four or more vertices are shown to tend to zero. copyright 1987 Academic Press, Inc.

26172 **Non-Grassmann formulation of regularized gauge theory with fermions.** Bern, Z.; Chan, H.S.; Halpern, M.B. (Lawrence Berkeley Lab., CA, USA; California Univ., Berkeley, USA. Dept. of Physics). *Zeitschrift fuer Physik [Sektion] C: Particles and Fields;* **34**: No. 2, 267-276(Mar 1987). Contract AC03-76SF00098.

Regularized continuum gauge theory coupled to quadratic matter simplifies significantly on integration of the matter fields. As an illustration, we discuss in some detail the resulting non-Grassmann formulation of regularized gauge theory with Dirac fermions.

26173 **Improved actions, redundant operators and scaling in lattice SU(3).** Patel, A.; Gupta, R. (California Univ., San Diego, La Jolla, USA. Dept. of Physics; Los Alamos National Lab., LANL, NM, USA. Theoretical Div.). *Physics Letters [Section] B;* **183**: No. 2, 193-201(8 Jan 1987). Contract AS03-81ER40029.

Schwinger-Dyson equations are used to systematically calculate redundant operators in lattice QCD and their role in peturbatively improved actions is analyzed. The criteria for improved actions in Monte Carlo simulations are discussed and their usefulness also. In particular the renormalized trajectory is estimated for the $b=\sqrt{3}$ renormalization group transformation in a four-parameter space and its scaling behavior is studied for future use in spectrum calculations.

26174 **Relative charge distributions for quarks in lattice mesons.** Wilcox, W.; Liu, K. (Department of Physics, University of Kentucky, Lexington, Kentucky 40506; TRIUMF, 4004 Wesbrook Mall, Vancouver, British Columbia, Canada V6T 2A3). *Physical Review [Section] D: Particles and Fields;* **34**: No. 12, 3882-3887(15 Dec 1986).

The relative charge distribution function for a quark-antiquark pair inside a pseudoscalar meson is measured using lattice techniques. We work in four space-time dimensions with quenched SU(2) color and Wilson fermions.

26175 **Static quark potential according to the dual-superconductor picture of QCD.** Baker, M.; Ball, J.S.; Zachariasen, F. (Department of Physics, University of Washington, Seattle, Washington 98195). *Physical Review [Section] D: Particles and Fields;* **34**: No. 12, 3894-3903(15 Dec 1986).

We use the effective action describing long-range QCD, which predicts that QCD behaves as a dual superconductor, to derive the interaction energy between two heavy quarks as a function of separation. The dual-superconductor field equations are solved in an approximation in which the boundary between the superconducting vacuum and the region of normal vacuum surrounding the quarks is sharp. Further, non-Abelian effects are neglected. The resulting heavy-quark potential is linear in separation at large separation, and Coulomb-like at small separation. Overall it agrees very well with phenomenologically determined potentials.

26176 **Scalar-quark production and decay: An exercise in jet spectroscopy.** Denham, S.A.; Jones, L.M. (Physics Department, University of Illinois, 1110 West Green Street, Urbana, Illinois 61801). *Physical Review* [*Section*] *D: Particles and Fields;* **34**: No. 11, 3354-3369(1 Dec 1986).

We use a Monte Carlo simulation of QCD and hadronization to simulate quark jets in the process $e^+e^-\rightarrow Z\rightarrow$q-tilde q-bartilde$\rightarrow$qq-bargamma-tildegamma-tilde. "Experimental" jets are then determined with a jet-finding algorithm. Manipulation of the four-vectors of these events allows us a fairly accurate determination of the scalar-quark mass used in the generation. We conclude that "jet-jet spectroscopy" is a useful approach to the discovery of new heavy particles.

26177 **Discrete mechanics.** Lee, T.D. (Colombia Univ., New York, NY). pp 15-114 of How far are we from the gauge forces. Zichichi, A. New York, NY; Plenum Press (1985). (CONF-8308166—).

From 21. meeting of the International School of Subnuclear Physics; Erice, Italy (3 Aug 1983).

This paper reviews the role of time throughout all phases of mechanics: classical mechanics, non-relativistic quantum mechanics, and relativistic quantum theory. As an example of the relativistic quantum field theory, the case of a massless scalar field interacting with an arbitrary external current is discussed. The comparison between the new discrete theory and the usual continuum formalism is presented. An example is given of a two-dimensional random lattice and its duel. The author notes that there is no evidence that the discrete mechanics is more appropriate than the usual continuum mechanics.

26178 **Lattice calculations in gauge theory.** Rebbi, C. (Brookhaven National Lab., Upton, NY). pp 115-155 of How far are we from the gauge forces. Zichichi, A. New York, NY; Plenum Press (1985). (CONF-8308166—).

From 21. meeting of the International School of Subnuclear Physics; Erice, Italy (3 Aug 1983).

The lattice formulation of quantum gauge theories is discussed as a viable technique for quantitative studies of nonperturbative effects in QCD. Evidence is presented to ascertain that whole classes of lattice actions produce a universal continuum limit. Discrepancies between numerical results from Monto Carlo simulations for the pure gauge system and for the system with gauge and quark fields are discussed. Numerical calculations for QCD require very substantial computational resources. The use of powerful vector processors of special purpose machines, in extending the scope and magnitude or the calculations is considered, and one may reasonably expect that in the near future good quantitative predictions will be obtained for QCD.

26179 **The U(1) problem: Instantons, axions, and familons.** Wilczek, F. (Univ. of California, Santa Barbara, CA). pp 157-229 of How far are we from the gauge forces. Zichichi, A. New York, NY; Plenum Press (1985). (CONF-8308166—).

From 21. meeting of the International School of Subnuclear Physics; Erice, Italy (3 Aug 1983).

The author discusses the motivation for introducing the axion and its mass and couplings to matter. Axions may play an important role in cosmology – they are a serious candidate to provide the nonluminous mass for which astronomical evidence is accumulating. The conversely cosmological considerations that place significant constraints on the properties of axions are examined. The framework in which axions most naturally appear is presented. It is noted that the whole superstructure of axions could be made obsolete if a good alternative approach to the problem of strong CP invariance were found. Techniques are presented for dealing with approximate Nambu-Goldstone bosons and their phenomenological (including cosmological) implications.

26180 **Limitations on universality in the continuous-spin Ising model.** Baker, G.A. Jr.; Johnson, J.D. (Los Alamos National Lab., NM). *Journal of Physics A: Mathematical and General;* **17**: L275-L278(1984).

The authors give by explicit counterexample numerical evidence that critical exponent universality fails for the two-dimensional, continuous-spin, Ising model. This result is contrary to what has previously been assumed. 17 references, 1 table.

65 PHYSICS II

26181 **(DOE/EA—0257) Environmental assessment: Continuous Electron Beam Accelerator Facility, Newport News, Virginia.** (Oak Ridge National Lab., TN (USA)). Jan 1987. Contract AC05-84OR21400. 119p. (ORNL/M—325). NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007730.

This Environmental Assessment has been prepared by the US Department of Energy (DOE) to fulfill its obligations pursuant to Sect. 102 of the National Environmental Policy Act (NEPA) of 1969 (Public Law 91-190). The proposed federal action addressed in this document is DOE's funding of a Continuous Electron Beam Accelerator Facility (CEBAF) at Newport News, Virginia. DOE intends to contract with the Southeastern Universities Research Association (SURA) for operation of CEBAF, a continuous wave (CW) linear accelerator system (linac) capable of providing high-duty-factor beams throughout the energy range from 0.5 to 4.0 GeV. CEBAF will be the first of its kind worldwide and will offer a multi-GeV energy, high-intensity, high-duty-factor electron beam for use by the US nuclear physics community in research on the states of nuclear matter and the short-distance behavior of nuclei. The CEBAF project is largely in the conceptual design stage, with some components in the preliminary design stage. Construction is anticipated to begin in 1987 and be completed by 1992.

6510 Nuclear Physics

26182 **(UCRL—95918) Calculation of excitation functions with code ALICE.** Blann, M. (Lawrence Livermore National Lab., CA (USA)). Apr 1987. Contract W-7405-ENG-48. 21p. (CONF-870490—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87007443.

From International Atomic Energy Agency coordinated research project on isotope production for medical applications; Tokyo, Japan (20 Apr 1987).

We illustrate the minimal input requirements necessary to use the code ALICE to predict excitation functions for light ion induced reactions up to energies of 200 MeV. 21 refs., 35 figs.

26183 **Atoms, radiation, and radiation protection.** Turner, J.E. Elmsford, NY; Pergamon Books Inc. (1986). 342p. Pergamon Books Inc., Manager/Publishing Services, Maxwell House, Fairview Park, Elmsford, NY 10523.

This book describes basic atomic and nuclear structure, the physical processes that result in the emission of ionizing radiations, and external and internal radiation protection criteria, standards, and practices from the standpoint of their underlying physical and biological basis. The sources and properties of ionizing radiation-charged particles, photons, and neutrons-and their interactions with matter are discussed in detail. The underlying physical principles of radiation detection and systems for radiation dosimetry are presented. Topics considered include atomic physics and radiation; atomic structure and radiation; the nucleus and nuclear radiation; interaction of heavy charged particles with matter; interaction of beta particles with matter; phenomena associated with charged-particle tracks; interaction of photons with matter; neutrons, fission and criticality; methods of radiation detection; radiation dosimetry; chemical and biological effects of radiation; radiation protection criteria and standards; external radiation protection; and internal dosimetry and radiation protection.

6511 Experimental Techniques

REFER ALSO TO CITATION(S) 26199

26184 (LA—10772-C, pp 2-23) **Polarized nuclear targets.** Jarmer, J.J. Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

The static and dynamic methods for producing polarized targets are briefly discussed and compared. Nuclei that have been polarized by these methods are summarized. The equipment necessary for producing a working target is described, as are the capabilities presently available at LAMPF. A short description is presented of a polarized ^{13}C target proposed for use at the LAMPF HRS spectrometer, as an example of a polarized target for use in nuclear physics research.

26185 (LA—10772-C, pp 24-37) **Prospects for polarizing various nuclei by microwave dynamic cooling in chemically-doped glasses.** Hill, D. (Argonne National Lab., IL). Aug 1986. (CONF-860279—). Contract W-31-109-ENG-38.

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

Factors are discussed which are on the practicality of polarized nuclear targets. A fully-enriched, polarized ^{13}C sample is also described. A table showing polarizability of stable nuclei is presented.

26186 (LA—10772-C, pp 38-40) **Polarization of nuclei other than ^{1}H or D by chemical doping.** Krumpolc, M. (Univ. of Illinois, Chicago). Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

A logical extension of the current research leads to polarization of heavier nuclei. This opens up vast and diverse chemistry of a number of elements and represents a challenging task in terms of chemical doping with paramagnetic pentavalent chromium. In order to select proper target media (nuclei) and assure their compatibility with currently used chromium(V) complexes, e.g. Cr(V)-EHBA, Cr(V)-HMBA, certain criteria must be met. A list of possible candidates meeting these conditions is given.

26187 (LA—10772-C, pp 171-195) **Electromagnetic physics with polarized targets.** Kowalski, S. (Massachusetts Institute of Technology, Cambridge). Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

The electromagnetic probe is a precise microscope for unravelling the structure of nucleons and nuclei. Much of the authors detailed knowledge of the charge and magnetization distribution in nuclei comes from high energy electron scattering where they can probe distances much less than 1 fm. A new generation of medium energy CW accelerators, 0.5 - 4 GeV are being developed to expand these capabilities, particularly those for coincidence experiments. They review briefly the theoretical framework and discuss a few examples of the physics problems that can be studied in the near future with longitudinally polarized electrons and/or polarized nuclear targets. The physics involves nuclear spectroscopy, nucleon structure and studies of reaction mechanisms.

6512 Nuclear Properties And Reactions, A=1-5, Experimental

26188 **Vector analyzing power at Theta/sub lab/ = 18^0 for the ^{2}H anti p,n)2p reaction at 21.3 MeV.** Nath, S.; Northcliffe, L.C.; Hiebert, J.C.; Woolverton, H.L.; York, R.L.; Graves, R.G.; Craft, B.C. III. (Texas A & M Univ., College Station). *Physical Review* [*Section*] *C: Nuclear Physics;* **30**: No. 5, 1386-1389(Nov 1984). Contract AS05-80ER10565.

The vector analyzing power A/sub y/(E/sub n/) for the breakup reaction ^{2}H(anti p,n)2p) at laboratory angle Theta/sub n/ = 18^0 has been measured for E/sub p/ = 21.3 MeV as a function of neutron energy. The experimental A/sub y/(E/sub n/) values are compared with the predictions of various three-nucleon Faddeev calculations. 20 references, 2 figures.

6514 Nuclear Properties And Reactions, A=20-38, Experimental

26189 **Single and correlated spin alignments for resonances in /sup 24/Mg + /sup 24/Mg inelastic scattering.** Wuosmaa, A.H.; Zurmuehle, R.W.; Kutt, P.H.; Pate, S.F.; Saini, S.; Halbert, M.L.; Hensley, D.C. (Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19104). *Physical Review Letters;* **58**: No. 13, 1312-1315(30 Mar 1987).

We have measured the single and correlated magnetic-substate population parameters for the 2^+ and 2^+-2^+ excitations in /sup 24/Mg+ /sup 24/Mg in the region of two strong resonances seen in inelastic scattering. We interpret our data in terms of an isolated resonance decaying through one preferred l value in both the 2^+ and 2^+-2^+ channels. Our data suggest a spin assignment of J/sup π/ = 36^+ for the resonance at E/sub c.m./ = 45.70 MeV, and a value of l = 34 for the grazing angular momentum for both the single and mutual inelastic-scattering channels.

6515 Nuclear Properties And Reactions, A=39-58, Experimental

26190 **Parity dependence of the level densities of ^{53}Cr and ^{55}Cr at high excitation.** Agrawal, H.M.; Garg, J.B.; Harvey, J.A. (State Univ. of New York, Albany). *Physical Review* [*Section*] *C: Nuclear Physics;* **30**: No. 6, 1880-1894(Dec 1984). Contract AC05-84OR21400;AC02-76ER02439.

The neutron total cross sections of ^{52}Cr and ^{54}Cr have been measured in the energy range from a few tens of keV to about 900 keV using a neutron time-of-flight technique and a pulsed electron linear accelerator. The nominal resolution of the measurements was about 0.06 ns/m. The total cross-section data have been analyzed using an R-matrix multilevel multichannel code to determine values of the resonance parameters (E_0, g Gamma/sub n/, and J/sup π/) and to investigate the parity dependence of the level densities of ^{53}Cr and ^{55}Cr at high excitation. The distributions of reduced neutron widths for s- and p-wave resonances for each isotope show good agreement with the Porter-Thomas distribution. The values of the Δ_3 statistic for the long-range correlation of s-wave resonances for both ^{52}Cr and ^{54}Cr are found to be in reasonable agreement with the theoretical prediction of Dyson and Mehta. The values for the ratio D_0/D_1 for both nuclides are larger than expected from a (2J + 1) level dependence, indicative of a parity dependence of the level densities of ^{53}Cr and ^{55}Cr at high excitation. 23 references, 14 figures, 8 tables.

6516 Nuclear Properties And Reactions, A=59-89, Experimental

26191 **/sup 87/Sr(d,p)/sup 88/Sr at 18 MeV and the 1g/sub 9/2/2d/sub 5/2/ multiplet.** Li, P.C.; Daehnick, W.W. (Pittsburgh Univ., PA, USA. Nuclear Physics Lab.). *Nuclear Physics* [*Section*] *A;* **462**: No. 1, 26-44(19 Jan 1987).

Differential cross sections for /sup 87/Sr(d,p)/sup 88/Sr transitions to the particle-hole states of /sup 88/Sr were obtained with the Pittsburgh 18 MeV deuteron beam and the Enge split-pole spectrography. States of /sup 88/Sr up to 7223 keV in excitation were studied with a total resolution of 16 keV. Finite-range and zero-range DWBA predictions were found to be in excellent agreement with each other and also in acceptable agreement with the data. For eleven levels, mixed l=2 and l=0 transitions were identified. Residual interaction matrix elements for the (1g/sup -1//sub 9/2/2d/sub 5/2/) multiplet were derived from the /sup 88/Sr data. Two potentially divergent results of /sup 91/Zr(p,d)/sup 90/Zr and /sup 91/Zr(/sup 3/He,α)/sup 90/Zr reactions for the (1g/sup -1//sub 9/2/2d/sub 5/2/) multiplet in /sup 90/Zr can be reconciled by allowing for l/sub n/ mixing. The revised /sup 90/Zr matrix elements are compared with the /sup 88/Sr result.

6518 Nuclear Properties And Reactions, A=150-189, Experimental

26192 (LA-UR—87-722) **Fragmentation in central collisions of heavy systems.** Claesson, G.; Doss, K.G.R.; Ferguson, R.; Gavron, A.; Gustafsson, H.A.; Gutbrod, H.H.; Harris, J.W.; Jacak, B.V.; Kampert, K.H.; Kolb, B. (Los Alamos National Lab., NM (USA); Lawrence Berkeley Lab., CA (USA); Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); Oak Ridge National Lab., TN (USA)). 1987. Contract W-7405-ENG-36. 6p. (CONF-870154—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007471.

From 15. international workshop on gross properties of nuclei and nuclear excitations; Hirschegg, Austria (12 Jan 1987).

One of the goals of heavy ion reaction studies is to understand the fragmentation of hot nuclei. The LBL/GSI Plastic Ball detector system has been used to achieve a very high solid angle for detection of light and medium-heavy fragments emitted in 200 Mev/A Au + Au and Au + Fe reactions. The simultaneous measurement of almost all of the nucleons and nuclei resulting from each collision allows an estimation of the total charged particle multiplicity and hence the impact parameter. By choosing subsets of the data corresponding to a peripheral or central collision, the assumptions inherent in various models of nuclear fragmentation can be tested. 3 refs., 3 figs.

26193 **Single particle and vibrational bands in ^{155}Gd, ^{161}Dy, and ^{163}Dy.** Schmidt, H.H.; Hungerford, P.; Egidy, T.V.; Scheerer, H.J.; Boerner, H.G.; Kerr, S.A.; Schreckenbach, K.; Hoyler, F.; Colvin, G.; Casten, R.F.; Warner, D.D. (Technische Universitaet Muenchen, Garching, West Germany). *AIP (American Institute of Physics) Conference Proceedings;* 406-409(1985).

The nuclei ^{155}Gd, ^{161}Dy and ^{163}Dy have been investigated by means of the (n,γ), (n,e) and transfer reactions. Level schemes have been constructed up to about 1.5 MeV, which include spin and parity assignments for many levels. New rotational bands based on single particle states (Nilsson) as well as on vibrational states have been identified. The results are discussed. 7 references, 8 figures.

6520 Nuclear Properties And Reactions, A=220 And Above, Experimental

26194 **Cold and hot fragmentation in thermal neutron induced fission of ^{245}Cm.** Koczon, P.; Mutterer, M.; Theobald, J.P.; Geltenbort, P.; Goennenwein, F.; Moore, M.S. (Technische Hochschule Darmstadt, Germany, F.R.; Institut Max von Laue - Paul Langevin, Grenoble, France; Los Alamos National Lab., NM). *Verhandlungen der Deutschen Physikalischen Gesellschaft;* 22: No. 4, C-1.5(1987). (CONF-8703106—).

From DPG spring meeting of the nuclear physics sections; Groningen, Netherlands (23 Mar 1987).

26195 **Measurements of the energy dependence of prompt neutron emission from /sup 233/U, /sup 235/U, and /sup 239/Pu for E/sub n/ = 0.0005 to 10 MeV relative to emission from spontaneous fission of /sup 252/Cf.** Gwin, R.; Spencer, R.R.; Ingle, R.W. (Oak Ridge National Lab., Oak Ridge, TN 37831). *Nuclear Science and Engineering;* **94**: No. 4, 365-379(Dec 1986). Contract AC05-84OR21400.

A series of experiments was performed to measure the dependence on the incident neutron energy of the average number of prompt neutrons emitted per fission from /sup 233/U, /sup 235/U, and /sup 239/Pu relative to the average number of prompt neutrons emitted in spontaneous fission of /sup 252/Cf. the incident neutron energy range was 0.0005 to 10 MeV. A white neutron source was generated by the Oak Ridge Electron Linear Accelerator, and the energies of the neutrons incident on the fissile samples were determined by time-of-flight techniques. In each experiment the samples, including the /sup 252/Cf standard, were contained in a fission chamber surrounded by a large volume (0.91 m/sup 3/) of liquid scintillator loaded with gadolinium. The fission chamber detected the fission events, and the scintillator detected the accompanying prompt neutrons. The resulting data were analyzed to yield: R-bar/sub rho/(E) = v-bar/sub rho/(E)(fissile)/v-bar/sub rho/(/sup 252/Cf). For /sup 235/U and /sup 239/Pu the results overlap, within the experimental uncertainty, the results of the evaluation of Manero and Konshin, and in the case of /sup 235/U the data show the same general structure apparent in the evaluation up to 0.5 MeV. Our R-bar/sub rho/(E) for /sup 233/U does not show the structure near 0.2 MeV obtained by Manero and Konshin.

6530 Nuclear Theory

REFER ALSO TO CITATION(S) 26159, 26192

26196 (LA—10772-C, pp 41-72) **Sensitivity of proton elastic scattering from polarized targets to relativistic dynamics in nuclei.** Ray, L. (Univ. of Texas, Austin). Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

The elastic scattering of intermediate energy polarized protons from polarized nuclear targets is considered within the framework of the relativistic impulse approximation and the Dirac equation. The results of these calculations suggest that several of the spin observables for elastic scattering of 500 MeV polarized protons from a polarized ^{13}C target are qualitatively sensitive to relativistic aspects of nuclear structure. Several computed spin observables also display qualitative sensitivity to the assumed form (pseudoscalar or pseudo-vector) of the large, pion coupling contribution to the relativistic nucleon-nucleon interaction. The dependences of the scattering observables on the upper component of the valence nucleon wave function, to the individual components of the projectile-nucleon effective interaction, and to distortion effects in the projectile wave function are also discussed. The utility of analyses of polarized target measurements for providing new information on the non-diagonal parts of the two-body effective interaction (i.e., those parts which couple upper and lower components as well as the double spin-flip terms) is also mentioned.

26197 (LA—10772-C, pp 73-98) **Polarized target observables for anti-p + ^{13}C vector reactions.** Shepard, J.R. (Univ. of Colorado, Boulder). Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

The general form of the scattering amplitude for the elastic scattering of protons from ^{13}C is examined and the observables which arise in the case of a polarized target are identified. Specific scattering amplitudes are calculated using the relativistic impulse approximation and observables which are sensitive to relativistic nuclear dynamics in the target wavefunctions are sought. In general, for elastic scattering, little sensitivity is found. What little is present is attributed to relativistic enhancements of the convection current. The (p,n) reaction to the analogue state in ^{13}N is also considered. Here great sensitivity to the use of the pseudovector or pseudoscalar form for the pseudoscalar NN invariant is found, the former being strongly preferred. Again, there is little evidence of sensitivity to relativistic dynamics in the nuclear bound states.

26198 (LA—10772-C, pp 100-115) **Nuclear structure and scattering.** Singham, M.K.; Johnson, M.B. Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

The authors outline a theoretical formalism that describes in a unified manner both scattering and nuclear structure properties, starting from a common, underlying Hamiltonian. The theoretical framework is applied to shell and collective models of nuclear structure.

26199 (LA—10772-C, pp 116-128) **Polarization effects in pion-nucleus scattering: general considerations.** Siciliano, E.R. Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

A multipole analysis of the pion-nucleus scattering amplitude is used to discuss the new information that may become available for pion scattering from polarized targets.

26200 (LA—10772-C, pp 129-137) **Pion elastic and single charge exchange scattering from polarized targets.** Ernst, D.J. (Texas A & M Univ., College Station). Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-360279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

Elastic and single charge exchange scattering from polarized targets is examined. Some examples of the type of physics which might be learned from these reactions are put forth and preliminary predictions of scattering asymmetries are presented.

26201 (LA—10772-C, pp 138-156) **Pion single-charge exchange from polarized nuclei.** Siegel, P.B.; Gibbs, W.R. Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

Asymmetry calculations for the reactions ^{13}C vector(π^+,π^0)^{13}N(IAS), ^{7}Li vector (π^+,π^0)^{7}Be(IAS), and ^{10}B vector(π^-, π^0)^{10}Be(g.s.) are presented in order to assess the potential of future experiments with polarized targets. The authors find that the asymmetry for pion charge exchange and pi-eta production from ^{10}B to the ground state of ^{10}C or ^{10}Be depends only on the difference in the distorted waves of the incoming and outgoing projectiles.

26202 (LA—10772-C, pp 157-170) **Neutron density deformation of ^{165}Ho.** Knudson, J.N. (Arizona State Univ., Tempe). Aug 1986. NTIS, PC A10/MF A01. File Number DE87000843. (CONF-860279—).

From Workshop on physics with polarized nuclear targets; Los Alamos, NM, USA (6 Feb 1986).

A description is given of an experiment where an oriented single-crystal ^{165}Ho sample will be used to determine the deformation of the neutron density distribution within the Ho nucleus. The motivation for employing pion single-charge exchange is developed, and results from a feasibility study are presented.

26203 **Angular momentum dynamics in damped nuclear reactions.** Bandrup, J.; Dossing, T. (NORDITA, Copenhagen). pp 69-98 of Heavy ion collisions. Bonche, P.; Levy, M.; Quentin, P.; Vautherin, D. New York, NY; Plenum Press (1986). (CONF-8409255—).

From Residential conference on reliability aspects: from devices to systems; Egham, UK (11 Sep 1984).

Damped nuclear reactions are studied in order to improve our understanding of macroscopic nuclear dynamics at moderate excitation. Towards this end, it is important to study angular-momentum related observables, as they carry considerable information about the reaction dynamics: While the correlated mass and charge distribution, which has received much attention in the past, can be characterized by two mean values and three second moments, the correlated fragment spin-spin distribution requires two mean values and thirteen non-trivial covariances. The first of the present two lectures discusses the dynamical accumulation of angular momentum in a damped nuclear reaction, as caused by the stochastic exchange of nucleons. The second lecture focuses on the description of the correlated angular distribution of fission fragments resulting from damped reaction products with correlated spins.

26204 **Nucleon- and antinucleon-nucleus scattering and spin-isospin response.** Carey, T.A. (Los Alamos National Lab., Los Alamos, NM). pp 475-478 of Antinucleon- and nucleon-nucleus interactions. Walker, C.E.; Goodman, C.E.; Olmer, C. New York, NY; Plenum Press (1985). (CONF-850315—).

From Conference on antinucleon and nucleon-nucleus interactions; Telluride, CO, USA (18 Mar 1985).

This article summarizes one part of the panel session concerning nucleon- and antinucleon-nucleus inelastic scattering and charge exchange. Assigned an unconstrained role, the author highlights the nucleon-nucleus case with his comments, and also discusses antinucleon-nucleus scattering.

26205 **Droplets of ^{3}He atoms.** Schmidt, K.E. (Los Alamos National Lab., NM). pp 33-39 of Monte Carlo methods in quantum problems. Kalos, M.H. (ed.). Hingham, MA; D. Reidel Publishing Company (1984).

Variational and Green's function Monte Carlo calculations within the fixed node approximation are performed on droplets of ^{3}He atoms. No bound states are found for droplet sizes of up to 40 atoms variationally, and up to 20 atoms using the Green's function Monte Carlo method. 9 references.

6540 Radiation And Shielding Physics

REFER ALSO TO CITATION(S) 25921, 25944, 26263, 26263

26206 **(LA—10844-PR) Radiation transport: Progress report, April 1, 1986-June 30, 1986.** O'Dell, R.D.; Nagy, A. (Los Alamos National Lab., NM (USA)). Jan 1987. Contract W-7405-ENG-36. 87p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87004772.

Research and development progress in radiation transport by the Los Alamos National Laboratory's Group X-6 for the third quarter of FY 86 is reported. Included are unclassified tasks in the areas of Monte Carlo Radiation Transport, Cross Sections and Physics, and Deterministic Radiation Transport.

26207 **(N—87-15782) Assessment of transport coefficient approximations used in galactic heavy ion shielding calculations.** Townsend, L. W.; Wilson, J. W. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Dec 1986. 17p. (NASA-TM—89054; NAS—1.15:89054). NTIS, PC A02/MF A01.

An energy-dependent, perturbation expansion solution for heavy ion transport in one dimension is used to perform depth-dose calculations for 670/MeV nucleon Ne-20 beams incident upon a thick water target. Comparisons of predictions obtained by using typical energy-independent approximations and those obtained with fully energy-dependent input parameters are made. It is found that the calculated doses are underestimated when the energy-independent input approximations are used. The major source of error, however, is the lack of charge and mass conservation in the Silberberg-Tsao fragmentation parameters.

26208 **Asymptotic solutions of numerical transport problems in optically thick, diffusive regimes.** Larsen, E.W.; Morel, J.E.; Miller W.F. Jr. (University of California, Los Alamos National Laboratory, Radiation Transport Group, X-6, Los Alamos, New Mexico 87545). *Journal of Computational Physics;* **69**: No. 2, 283-324(Apr 1987).

We present an asymptotic analysis of spatial differencing schemes for the discrete-ordinates equations, for diffusive media with spatial cells that are not optically thin. Our theoretical tool is an asymptotic expansion that has previously been used to describe the transform from analytic transport to analytic diffusion theory for such media. To introduce this expansion and its physical rationale, we first describe it for the analytic discrete-ordinates equations. Then, we apply the expansion to the spatially discretized discrete-ordinates equations, with the spatial mesh scaled in either of two physically relevant ways such that the optical thickness of the spatial cells is not small. If the result of either expansion is a legitimate diffusion description for either the cell-averaged or cell-edge fluxes, then we say that the approximate flux has the appropriate diffusion limit; otherwise, we say it does not. We consider several transport differencing schemes that are applicable in neutron transport and thermal radiation applications. We also include numerical results which demonstrate the validity of our theory and show that differencing schemes that do have a particular diffusion limit are substantially more accurate, in the regime described by the limit, than those that do not. copyright 1987 Academic Press, Inc.

26209 **First-flight escape from spheres with R^{-2} density distribution.** Huebner, W.F.; Keady, J.J. (Max-Planck-Institut fuer Physik and Astrophysik, Garching bei Muenchen, West Germany). *Astronomy and Astrophysics;* **135**: 177-180(1984).

Energy independent first-flight transport kernels are evaluated for a spherical region with an R^{-2} density distribution. The uncollided angular flux distribution is obtained and integrated for a source distribution that is proportional to the density to give the uncollided, emitted particle flux and current density. These are useful for the calculation of mass, energy, and momentum carried away by fast particles born in the medium. The data are relevant to estimate escape from weakly bound atmospheres such as comet comae, dilute circumstellar envelopes, and some unconfined laboratory plasmas. 4 references, 3 figures, 1 table.

6550 Medical Physics

REFER ALSO TO CITATION(S) 25892, 25898, 25928, 25936, 26183

26210 (CONF-851113—, pp 562-573) **Effect of tissue inhomogeneity on beta dose calculation.** Kowk, C.S.; Irfan, M.; Woo, M.K.; Prestwich, W.V. (Ontario Cancer Foundation, Hamilton). Apr 1986. NTIS, PC A99/MF A01. File Number DE86010102.

From Radiopharmaceutical dosimetry symposium; Oak Ridge, TN, USA (5 Nov 1985).

Appropriate monoclonal antibodies labeled with beta-emitting nuclides of high specific activity have been suggested for treatment of specific tumors. In a homogeneous medium the radiation dose rate distribution R due to a distributed activity distribution C can be calculated by convolution of the beta dose point kernel of the radionuclide in soft tissue with C. Prototype computer programs using Fast Fourier Transform techniques have been developed to evaluate the three dimensional spatial convolution efficiently. To study the effect of tissue inhomogeneity on R, the authors simulated a soft tissue-bone interface by a polystyrene (PST)-aluminum (A1) interface and considered the backscattering of beta rays from a point source and a plane source of ^{32}P. LiF thermoluminescent dosimeters were used. With the point source at the PST-A1 interface, R at 0-31, 125-156, and 283-314 mg/cm^2 separations from the interface were increased by (12 +/- 3)%, (8 +/- 2)%, and (3 +/- 2)%, respectively, compared with a PST-PST interface. With the plane source, the increases were (8 +/- 3)%, (6 +/- 3)%, and (5 +/- 5)% for separations of 23-58, 150-184, and 277-311 mg/cm^2, respectively. With the point source at a PST-air interface to simulate soft tissue-air interface, R at 0-31, 139-170, and 283-314 mg/cm^2 from the interface were decreased by (25 +/- 4)%, (11 +/- 7)%, and (5 +/- 2)%, respectively. The changes in R have also been measured with degraded spectra of ^{32}P. Comparison of the experimental data with Monte Carlo calculation and the Two-Group method of calculation will be discussed. 20 references, 6 figures, 2 tables.

26211 (ORAU—280) **Expanding training programs to meet new DOE requirements: Selected proceedings.** (Oak Ridge Associated Universities, Inc., TN (USA)). Mar 1987. Contract AC05-76OR00033. 60p. (CONF-8610178—). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87007654.

From TRADE conference; Las Vegas, NV, USA (27 Oct 1986).

The Health Physics Branch, Office of Nuclear Safety, is currently reassessing the Department of Energy's radiation protection policy. This includes establishing more definitive and explicit requirements for training all contractor employees in radiation protection at a level commensurate with their job responsibilities. The papers contained in this proceedings represent various approaches taken by DOE contractors to prepare for these pending requirements, as well as those recently issued for hazard communication. Current activities of the Radiation Protection Training Special Interest Group are directed toward assisting contractors in preparing for the training requirements in draft 5480.11. Recent activities include: the development of a resources guide in radiation protection training; the sharing of information and materials on in-house training programs; exchanging ideas and experiences on ways to enhance training programs; and the development of a "code-of-good-practice" for training to include guidance on certification of radiation workers and radiation protection technicians. 26 figs., 1 tab.

6560 Condensed Matter Physics

REFER ALSO TO CITATION(S) 25235, 25296, 25297, 25696, 26043, 26045, 26059, 26060, 26061, 26062, 26082, 26094

26212 (CONF-8611121—2) **New concepts in surface-enhanced Raman scattering (SERS).** Ferrell, T.L. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 5p. NTIS MF A01; 2; GPO Dep. File Number DE87004075.

From Conference on chemical defense research; Aberdeen Proving Grounds, MD, USA (15 Nov 1986).

Use of new methods in submicron physics, including scanning-tunneling electron microscopy, are shown to both produce and characterize novel microbases used to enhance the Raman detection of organophosphonates and other compounds. An inexpensive and portable SERS system made feasible by these developments is described. Submonolayer amounts of compounds on surfaces are shown to be detectable with the portable system. Various microbase materials, including silver and gold, are compared in optimum configurations. Results of scanning-tunneling microscopy of the microbases used in SERS are displayed, and some other potential uses of this new type of microscopy are given.

26213 (LA—10959-MS) **The use of molecular dynamics for the thermodynamic properties of simple and transition metals.** Straub, G.K. (Los Alamos National Lab., NM (USA)). Apr 1987. Contract W-7405-ENG-36. 36p. NTIS, PC A03/MF A01; GPO Dep. File Number DE87007718.

The technique of computer simulation of the molecular dynamics in metallic systems to calculate thermodynamic properties is discussed. The nature of a metal as determined by its electronic structure is used to determine the total adiabatic potential. The effective screened ion-ion interaction can then be used in a molecular dynamics simulation. The method for the construction of a molecular dynamics ensemble, its relation to the canonical ensemble, and the definition of thermodynamic functions from the Helmholtz free energy is given. The method for the analysis of the molecular dynamics results from quasiharmonic lattice dynamics and the decomposition in terms of harmonic and anharmonic contributions is given for solids. For fluid phase metals, procedures for calculating the thermodynamics and determining the constant of entropy are presented. The solid-fluid phase boundary as a function of pressure and temperature is determined using the results of molecular dynamics. Throughout, examples and results for metallic sodium are used. The treatment of the transition metal electronic d-states in terms of an effective pair-wise interaction is also discussed and the phonon dispersion curves of Al, Ni, and Cu are calculated.

26214 (SAND—87-0614C) **Far infrared reflectance spectroscopy of AlAs-GaAs microstructures.** Sudharsanan, R.; Perkowitz, S.; Yom, S.S.; Drummond, T.J. (Emory Univ., Atlanta, GA (USA). Dept. of Physics; Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 5p. (CONF-870385—6). NTIS, PC A02. File Number DE87007388.

From SPIE conference on growth of compound semiconductors; Bay Point, FL, USA (22 Mar 1987).

We report infrared reflectance spectra in the range 100 to 450 cm^{-1} for an AlAs-GaAs heterostructure and three AlAs-GaAs superlattices with different periods. All the spectra clearly exhibit the TO phonon modes of pure GaAs and AlAs and a sharp interference peak at the GaAs LO frequency. The heterostructure data yield a set of phonon parameters for unoxidized AlAs. The superlattice spectra exhibit additional structure between 225 and 400 cm^{-1} and a broadening of the GaAs TO peak. The long wavelength superlattice optical theory of Agranovich and Kravtsov explains most of the features of the superlattice reflectivity. 15 refs., 2 figs., 1 tab.

26215 Energy-dependent electron backscattering coefficient. Williamson W. Jr.; Antolak, A.J.; Meredith, R.J. (Department of Physics and Astronomy, University of Toledo, Toledo, Ohio 43606). *Journal of Applied Physics;* **61**: No. 9, 4612-4618(1 May 1987).

An energy-dependent electron backscattering coefficient is derived based on the continuous slowing down approximation and the Bethe stopping power. Backscattering coefficients are given for 10—50-keV electrons incident on bulk and thin-film aluminum, silver, and gold targets. The results are compared with the Everhart theory and empirical fits to experimental data. The energy-dependent theory agrees better with experimental work.

26216 Effect of chemical and elastic interactions on the phase diagrams of isostructural solids. Ferreira, L.G.; Mbaye, A.A.; Zunger, A. (Solar Energy Research Institute, Golden, Colorado 80401). *Physical Review [Section] B: Condensed Matter;* **35**: No. 12, 6475-6478(15 Apr 1987).

It is shown how the introduction of volume-dependent elastic interactions into lattice models of order-disorder transformations, in addition to the familiar constant-volume interactions (analogous to Ising "spin energies"), leads to qualitatively new features in a binary A/sub x/B/sub 1-x/ phase diagram.

26217 Multiple-scattering treatment of surfaces and interfaces. Gonis, A. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201). *Physical Review [Section] B: Condensed Matter;* **34**: No. 12, 8313-8317(15 Dec 1986).

A formally exact method for treating semi-infinite solids and thus for evaluating the Green's function at or near surface regions is presented. This method is based on a combined real-space—reciprocal-space formulation of the well-known Korringa-Kohn-Rostoker multiple-scattering theory or Green's function method and can be used to study a variety of physically important problems such as impurities, substitutional or interstitial, near surfaces or interfaces, surface reconstruction, and others. The advantages and computational requirements of the formalism are discussed.

26218 Theory of hopping conduction by the path-probability method. Ishii, T.; Sato, H.; Kikuchi, R. (School of Materials Engineering, Purdue University, West Lafayette, Indiana 47907). *Physical Review [Section] B: Condensed Matter;* **34**: No. 12, 8335-8344(15 Dec 1986).

Based on the pair approximation of the path-probability method, the frequency-dependent conductivity $\sigma(\omega)$ is formulated both in the ordered and in the disordered phase in a binary system. Especially in the disordered phase, the effects of pair correlation on $\sigma(\omega)$ are analytically shown and discussed. The present method is found to provide information in a more organized way than in the commonly adopted master-equation method.

26219 Some consequences of the closure of the momentum Bloch functions. Elci, A.; Jones, E.D. (Department of Physics and Astronomy, University of New Mexico, Albuquerque, New Mexico 87131). *Physical Review [Section] B: Condensed Matter;* **34**: No. 12, 8611-8615(15 Dec 1986).

We present a proof of the closure property of the momentum Bloch functions directly from the Schroedinger equation. We derive from this property several new relations involving the crystal potential, energy-band values at a fixed point in the first Brillouin zone, and the momentum matrix elements. These relations determine the crystal potential from the energy-band values and the Bloch functions at $k = 0$, and permit application of the kxp method to the momentum Bloch functions.

26220 Local density approach to surfaces and adsorbed layers. Wimmer, E.; Freeman, A.J.; Weinert, M. (Northwestern Univ., Evanston, IL). pp 593-604 of Local density approximations in quantum chemistry and solid state physics. Dahl, J.P.; Avery, J. New York, NY; Plenum Press (1986). (CONF-8206289—).

From Local density approximations in quantum chemistry and solid state theory conference; Copenhagen, Denmark (10 Jun 1982).

The authors show that the local density problem for the thin film geometry can be solved with high accuracy by employing the all-electron full-potential linearized augmented-plane-wave method. This is achieved by removing all shape approximations in the charge density and the potential and by using a highly flexible variational basis set. Also demonstrated is the fact that for a graphite monolayer, local density total energies give excellent descriptions of equilibrium geometries and discuss the overestimation of local-density cohesive energies due to an incomplete treatment of correlation effects in the free atom.

26221 Dynamical effects and the critical behavior of random-field systems. Shapir, Y. (Brookhaven National Lab., Upton, NY). *Journal of Applied Physics;* **57**: No. 1, 3279-3284(15 Apr 1985).

A variety of phenomena is observed experimentally in random-field (RF) systems realized by the application of an external field to diluted antiferromagnets. At low temperatures, infinitely long hysteretic effects are manifested by the history dependence of the final states: long-range order is observed if the field is applied after cooling, while domain states are reached when field cooled. While no indications for critical fluctuations are detected in 2-D systems, scaling behavior, for both the correlation length and the specific heat, is observed in 3-D systems over an intermediate range of temperatures. The related critical properties seem to be well described by the corresponding ones in the 2-D pure Ising model. The renormalization-group approach, which yields for the equilibrium critical exponents their values of the pure model in d-2 dimensions, is reviewed. A generalization of the dimensional-reduction approach, which accounts self-consistently for renormalized responses of the RF system, is presented. The dynamical effects are implicitly incorporated through the variation in the critical response between the local and the global regimes, associated with short- and long-time scales, respectively. In both regimes the lower critical dimension is found to be $d = 2$ in accordance with stability arguments. The short-time critical behavior indicates a dimensional reduction by one for the 3-D thermal exponents, in agreement with the experimental results. 37 references.

26222 Interface displacement for transient pulses in viscoelastic media. Pound, M.J. (Univ. of California, Davis). *Wave Motion;* **7**: 271-282(1985). Contract W-7405-ENG-48.

The authors investigate the problem of the displacement of the interface between two linear viscoelastic media under the influence of a transient incident pulse. An exact solution is given for the case when the incident signal is a Dirac delta-function, while asymptotic expressions are developed for a more complicated case. It is shown that the interface displacement may differ greatly in form from the incident signal. 11 references, 6 figures.

26223 Nonlinear adiabatic dynamics in polyacetylene and related materials. Bishop, A.R.; Campbell, D.K.; Lomdahl, P.S.; Phillpot, S.R.; Baeriswyl, D.; Horovitz, B. (Los Alamos National Lab., NM). *Molecular Crystals and Liquid Crystals;* **118**: 65-73(1985).

Numerical and analytical studies of the dynamic, mean-field, adiabatic Su-Schrieffer-Heeger model of polyacetylene are shown to reveal the typical importance of strong, coherent anharmonicity, e.g. as breathers. Examples illustrated include (i) single kink dynamics, (ii) electron-hole (e-h) decay in trans-(CH)/sub x/; (iii) e-h decay in cis-(CH)/sub x/; (iv) e-h decay in linear polyynes; (v) decay of a photoexcited kink or polaron; (vi) photoexcitation in the presence of bond or site defects. 18 references, 4 figures.

26224 Anomalous rigid-layer modes in layered compounds. Sokoloff, J.B.; Alzyab, B. (Northeastern Univ., Boston, MA). *Molecular Crystals and Liquid Crystals;* **121**: 161-164(1985).

Layered compounds, such as graphite, consist of stacked layers of atoms with strong coupling within a layer but much weaker interactions between layers. It is shown that the presence of weak random impurities in such crystals results in an anomalous term in the Green's function for the rigid-layer phonon modes. This term, which is a consequence of the fact that an individual layer behaves as a two dimensional solid to lowest order, results in a peak in the spectral function centered around zero frequency omega and decaying as omega/sup -α/, where the exponent α is a decreasing function of the temperature, having a value of one at zero temperature. 1 reference, 2 figures.

26225 **Pressure tuning of electronic energy levels.** Drickamer, H.G. (Univ. of Illinois, Urbana). pp 25-30 of Solid state physics under pressure: recent advance with anvil devices. Minomura, S. (ed.). Tokyo, Japan; KTK Scientific Publishers (1985). Contract AC02-76ER01198.

The electronic properties of solids depend on the characteristics of the ground state and electronic arrangements and energies of various excited states. The effect of pressure is to tune these various states with respect to one another. In this paper the authors outline the various classes of consequences of this pressure tuning and give a few examples from their result selected to show the versatility of the pressure tuning techniques. 10 references.

26226 **Comment on deconvolution of partial pair correlation functions of an n component system using n diffraction experiments.** Guttman, L.; Rahman, A. (Argonne National Lab., IL). *Physics Letters* [*Section*] *A;* **100A**: No. 5, 250(30 Jan 1984).

The general result of the paper of Dolgopolsky and Johnson is shown to be erroneous.

26227 **Comparison of the dynamic response of the ACS and SLS models for linear viscoelasticity.** Pound, M.J.; Chin, R.C.Y.; Hedstrom, G.W. (Lawrence Livermore National Lab., CA). *Wave Motion;* **6**: 23-32(1984). Contract W-7405-ENG-48.

Using asymptotic analysis and numerical computation, the authors compare the behavior of the three-parameter viscoelastic model proposed by Achenbach and Chao (ACS) with that of the Standard Linear Solid (SLS) in one-dimensional wave propagation. Their study shows that the models behave very similarly in both the near and far fields and that the much simpler form of the fundamental solution for the Achenbach-Chao model may make it preferable in many applications. 8 references, 3 figures, 1 table.

26228 **A Lie-transformed action principle for classical plasma dynamics.** Kaufman, A.N. (Lawrence Berkeley Lab. and Physics Dept., Univ. of California, Berkeley, CA 94720). pp 26-30 of Group theoretical methods in physics. Zachary, W.W. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8405168—).

From International colloquium on group theoretical methods in physics; College Park, MD, USA (21 May 1984).

The Lie transform for a single particle in a wave is imbedded in a Lagrangian action principle for self consistent plasma dynamics. Variation of the action then yields the Vlasov equation for the oscillation-center distribution, the ray equations and amplitude transport for the wave, and the Poisson equation for the quasistatic field.

26229 **Structural transition and charge density waves in thin films.** Kresin, V.Z. (Lawrence Berkeley Lab., CA). *Journal of Low Temperature Physics;* **57**: No. 5-6, 549-561(1984).

A special type of low-temperature structural transition occurs in thin, size-quantized films with a strong anisotropy of the Fermi curve (e.g., in Bi films). The lattice appears to be unstable for such films. The structural transition is accompanied by the appearance of charge density waves and is characterized by peculiar temperature and thickness dependences of the electron concentration. Experimental data can be explained by the present theory. The possibility of new experimental investigations is discussed. 35 references, 2 figures.

26230 **Microdiffraction and stem of interfaces.** Cowley, J.M. (Arizona State Univ., Tempe). *Ultramicroscopy;* **14**: 27-36(1984). Contract AC02-76ER02995.

The techniques which have been developed for using very fine electron beams for the study of solid-vacuum interfaces may be applied to solid-solid interfaces with some restrictions. The nanodiffraction patterns obtained with the electron beam parallel to the interface may show the refraction effects and the extra spots due to surface channelling, and corresponding effects may be expected in high resolution images. The contributions of interface energy states to EELS spectra will be more difficult to detect. The images of features and interfaces not parallel to the incident beam which are most directly interpretable should be the dark-field STEM images obtained by detecting all the diffuse scattering outside of the main spots of the microdiffraction pattern. To a reasonable approximation the image intensities should be given by the convolution of the intensity distribution of the beam incident at the feature and the scattering power of the feature itself. 20 references, 2 figures.

26231 **Optically induced intervalence-band transitions in germanium by the absorption of 1.06 μm picosecond pulses.** James, R.B. (Oak Ridge National Lab., TN). *Proceedings of the International Conference on Lasers;* 321-331(1983). Contract W-7405-ENG-26.

The intervalence-band adsorption coefficient in germanium is calculated as a function of the hole density and temperature for light with a wavelength of 1.06 μm. This adsorption mechanism is normally negligible compared to the interband absorption; however, for a sufficiently dense electron-hole plasma, the free-hole intervalence-band adsorption can become comparable to the interband adsorption. Furthermore, the interaction of intense 1.06 μm light can alter the distribution of resonantly-coupled hole states and lead to an intensity dependence in the intervalence-band absorption cross section. For a fixed hole density, the intervalence-band cross sections due to free-hole transitions between the heavy- and split-off hole bands and between the light- and split-off hole bands are found to decrease with increasing intensity in a manner closely approximated by an inhomogeneously broadened two-level model. Values for the saturation intensity of each resonant transition are calculated as a function of the hole density and temperature. The intensities required to begin to saturate the direct free-hole transitions are easily attainable using picosecond pulses. 31 references, 4 figures.

26232 **Photothermal displacement spectroscopy: an optical probe for solids and surfaces.** Olmstead, M.A.; Amer, N.M.; Kohn, S.; Fournier, D.; Boccara, A.C. (Lawrence Berkeley Lab., CA). *Applied Physics,* [*Part*] *A: Solids and Surfaces;* **A32**: 141-154(1983). Contract AC03-76SF00098.

The authors present a sensitive technique for determining the optical and thermal properties of solids, surfaces and thin films. This technique, photothermal displacement spectroscopy, is based on the detection of the thermal expansion of a sample upon absorption of electromagnetic radiation. The technique is well suited for in situ ultrahigh vacuum studies and for experiments where wide temperature ranges are required. The authors show that surface and bulk optical absorption can be distinguished and that surface absorptions of $\alpha L = 10^{-6}$/W of incident power can be measured. The theoretical basis of the signal generation is given, and excellent experimental and theoretical agreement is demonstrated. The implications of the authors findings to imaging and microscopy are discussed. 13 references, 6 figures.

6561 Superconductivity

REFER ALSO TO CITATION(S) 25210, 25326, 25331

26233 **Josephson junctions and circle maps.** Bak, P.; Bohr, T.; Jensen, M.H.; Christiansen, P.V. (Brookhaven National Lab., Upton, NY). *Solid State Communications;* **51**: No. 4, 231-234(1984). Contract AC02-76CH00016.

The return map of a differential equation for the current driven Josephson junction, or the damped driven pendulum, is shown numerically to be a circle map. Phase locking, noise and hysteresis, can thus be understood in a simple and coherent way. The transition to chaos is related to the development of a cubic inflection point. Recent theoretical results on universal behavior at the transition to chaos can readily be checked experimentally by studying I-V characteristics. 17 references, 1 figure.

6570 Theoretical And Mathematical Physics

REFER ALSO TO CITATION(S) 25344, 25413, 26122, 26177, 26177, 26227, 26381

26234 **(N—87-16464) Comparison of relativistic effects in barycentric and Earth-centered coordinates and implications for determination of GM for Earth.** Ashby, NEIL. (Colorado Univ., Boulder (USA). Cooperative Inst. for Research in Environmental Sciences). Jan 1987. 24p. (NASA-CR—180121; NAS—1.26:180121). NTIS, PC A02/MF A01.

The results of an investigation of relativistic effects which have an influence on the determination of GM sub E (M sub E is the mass of the Earth, G is the Newtonian gravitaional constant) are summarized. The detailed arguments and derivations are discussed. The Parametrized Post-Newtonian (PPN) coordinates; Eddington-Clark (EC) coordinates; a coordinate system based on barycentric dynamical time (TBC coordinates); and Local Inertial coordinates are discussed.

26235 **(SAND—87-0011) Single and multiple electromagnetic scattering by dielectric obstacles from a resonance perspective.** Riley, D.J. (Sandia National Labs., Albuquerque, NM (USA). Electromagnetic Applications Div.). Mar 1987. Contract AC04-76DP00789. 127p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87007347.

A new application of the singularity expansion method (SEM) is explored. This application combines the classical theory of wave propagation through a multiple-scattering environment and the SEM. Because the SEM is generally considered to be a theory for describing surface currents on conducting scatters, extensions are made which permit, under certain conditions, a singularity expansion representation for the electromagnetic field scattered by a dielectric scatterer. Application of this expansion is then made to the multiple-scattering case using both single and multiple interactions. A resonance scattering tensor form is used for the SEM description which leds to an associated tensor form for the solution to the multiple-scattering problem with each SEM pole effect appearing explicitly. The coherent field is determined for both spatial and SEM parameter random variations. A numerical example for the case of an ensemble of dielectric spheres which possess frequency-dependent loss is also made. Accurate resonance expansions for the single-scattering problem are derived, and resonance trajectories based on the Debye relaxation model for the refractive index are introduced. Application of these resonance expansions is then made to the multiple-scattering results for a slab containing a distribution of spheres with varying radii. Conditions are discussed which describe when the hybrid theory is appropriate. 53 refs., 21 figs., 9 tabs.

26236 **(SAND—87-0524C) Issues in numerical calculations of atomic Rayleigh scattering near edges.** Kissel, L. (Sandia National Labs., Albuquerque, NM (USA)). 28 Feb 1987. Contract AC04-76DP00789. 19p. (CONF-870353—2-Vugraphs). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006901.

From Annual SDI technical achievements symposium; Pacific Grove, CA, USA (1 Mar 1987).

An overview of the relativistic S-matrix approach to the calculation of x-ray scattering is presented. Relativistic quantum electrodynamics, treated in lowest nonvanishing order in e^2, provides the basic theoretical framework for this description of elastic photon-atom scattering. Rayleigh scattering is calculated as a second-order single-electron transition process from electrons bound in a relativistic self-consistent central potential. This method has previously been applied to the soft gamma-ray region of 100 keV to 10 MeV. Good agreement has been generally found in extensive comparisons with available experiments for these energies. For scattering near atomic thresholds, errors in the detailed predictions of the self-consistent field model of the atom for electron binding energies are important. Two methods are presented for improving the predictions of this single-particle model near thresholds. Predictions from the unmodified and modified S-matrix approach are compared with experiment and simpler theories for an energy near the K-edge of ^{54}Xe.

26237 **(UCRL—96074) Scattering from an open spherical shell having a circular aperture and enclosing a concentric dielectric sphere.** Ziolkowski, R.W.; Marsland, D.P.; Libelo, L.F.; Pisane, G. (Lawrence Livermore National Lab., CA (USA); Harry Diamond Labs., Adelphi, MD (USA)). Feb 1987. Contract W-7405-ENG-48. 33p. NTIS MF A01; 2; GPO Dep. File Number DE87007099.

The generalized dual series solution to the scattering of an arbitrary plane wave from an open spherical shell having a circular aperture and enclosing a concentric, homogeneous dielectric sphere is presented. This solution explicitly exhibits the correct edge behavior, and it can handle spheres that are electrically small or large without special considerations. A variety of cross-section results are presented for the normally incident case. It is shown that effects corresponding to the presence of the interior cavity dominate all of the scattering data. In particular, the cross-sections exhibit new resonance features that are due to the cavity-backed nature of the aperture and depend on the characteristics of the interior sphere. The results demonstrate that interior information is contained in the exterior scattering data.

26238 **New class of lattice identities.** Low, F.E. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Journal of Mathematical Physics (New York);* **28**: No. 5, 1089-1090(May 1987).

Some identities involving two-dimensional lattice sums of a class of integrals are derived. A simple application to theta functions is given.

26239 **Nonlinear Boltzmann equation with partially absorbing boundary conditions. Global existence and uniqueness results.** Toscani, G.; Protopopescu, V. (Dipartimento di Matematica, Universita-grave-accent di Ferrara, 44100 Ferrara, Italy). *Journal of Mathematical Physics (New York);* **28**: No. 5, 1140-1145(May 1987).

The method applied by Bellomo and Toscani [J. Math. Phys. 26, 334 (1985)] for the Boltzmann equation in an infinite medium to establish global results for bounded media with partially absorbing boundary conditions is generalized. The method does not require that the equilibrium solution be the vacuum state and, accordingly, does not rely on positivity/monotonicity arguments. The growth produced by the nonlinearity is compensated by the combined effect of streaming and (partial) absorption (leakage) at the boundary.

26240 **Generalized Riccati equations for self-dual Yang—Mills fields.** Chau, L.; Yen, H.C. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Journal of Mathematical Physics (New York);* **28**: No. 5, 1167-1169(May 1987).

It is shown that although no Riccati equations in the strict sense are likely to exist for the self-dual Yang—Mills fields, certain "generalized Riccati equations" derivable from the Baecklund transformation do exist, and are capable of reproducing the linear system when a certain contraint is imposed.

26241 **Four-dimensional eikonal theory of linear mode conversion.** Friedland, L.; Goldner, G.; Kaufman, A.N. (Center for Plasma Physics, Racah Institute of Physics, Hebrew University, Jerusalem, Israel). *Physical Review Letters;* **58**: No. 14, 1392-1394(6 Apr 1987).

The problem of linear mode conversion in nonuniform media is solved for general geometry, in that the dispersion functions D/sub a/(k,x),D/sub b/(k,x) of the two, orthogonally polarized, coupled modes a,b have spatial gradients partialD/sub a//partialx/sup μ/,partialD/sub b//partialx/sup μ/ which need not be parallel. The transmission ratio is found to be exp(-2πchemical bondetachemical bond^2/chemical bondBchemical bond), where eta is the coupling coefficient, and B is the Poisson Bracket {D/sub a/,D/sub b/} = (partialD/sub a//partial/sub X//sup μ/)(partialD/sub b//partialk/

sub μ/)D/sub b/) -(partialD/sub a//partialK/sub μ/)(partialD/sub b//partial/sub X//sup μ/). /partialx/sup μ/). The further generalization to weak dissipation and ray divergence is included.

26242 **Maslov indices of resonant tori.** Robbins, J.M.; Littlejohn, R.G. (Department of Physics, University of California, Berkeley, California 94720). *Physical Review Letters;* **58**: No. 14, 1388-1391(6 Apr 1987).

It is well known that the resonant tori of an integrable, classical Hamiltonian system break up under a small perturbation into new tori which wind around the remaining nonresonant tori. It turns out that the Maslov indices of one of these satellite tori depend on the Maslov indices of its unperturbed, resonant parent, and on the integers which enter into the resonance condition. They do not, however, depend on the functional form of the Hamiltonian or the perturbation. Our results are valid for any number of degrees of freedom.

26243 **Lattice Virasoro algebra and corner transfer matrices in the Baxter eight-vertex model.** Itoyama, H.; Thacker, H.B. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Physical Review Letters;* **58**: No. 14, 1395-1398(6 Apr 1987).

A lattice Virasoro algebra is constructed for the Baxter eight-vertex model. The operator L_0 is obtained from the logarithm of the corner transfer matrix and is given by the first moment of the XYZ spin-chain Hamiltonian. The algebra is valid even when the Hamiltonian includes a mass term, in which case it represents lattice coordinate transformations which distinguish between even and odd sublattices. We apply the quantum inverse scattering method to demonstrate that the Virasoro algebra follows from the Yang-Baxter relations.

26244 **New tool for quantum many-body theory.** Baker G.A. Jr. (Theoretical Division, Los Alamos National Laboratory, University of California, Los Alamos, Los Alamos, New Mexico 87545). *Physical Review Letters;* **58**: No. 13, 1379-1379(30 Mar 1987).

A Comment on the Letter by J. Cioslowski, Phys. Rev. Lett. 58, 83 (1987).

26245 **N dependence of coherent radiation from crystals.** Lipkin, H.J. (Argonne National Laboratory, Argonne, Illinois 60439; Department of Nuclear Physics, Weizmann Institute of Science, Rehovot 76100, Israel). *Physical Review Letters;* **58**: No. 12, 1176-1179(23 Mar 1987). Contract W-31-109-ENG-38.

The total intensity averaged over all angles of short-wavelength radiation either scattered or spontaneously emitted nearly isotropically from each of a system of N radiators or scatterers is shown to vary linearly with N for large N. Although coherent effects can give intensities proportional to N^2 in certain directions (e.g., Bragg angles), this enhancement is mainly at the expense of radiation otherwise emitted in other directions and does not appear in the overall angular distribution.

26246 **Effect of an external field on a modification of Luttinger's many-fermion model.** Orfanopoulos, B.A.; Percus, J.K. (Courant Institute of Mathematical Sciences and Physics Department, New York University, New York, New York 10012). *Journal of Statistical Physics;* **46**: No. 2, 525-534(Feb 1987).

A modification is given of Luttinger's one-dimensional model of interacting fermions to incorporate both Fermi surfaces using one physical type of particle. The system is solved in the presence of an arbitrary external field, with linear response and pair correlation functions readily computed. These constitute and explicit realization of a relation associated with the random phase approximation.

26247 **Enskog theory for multicomponent mixtures. IV. Thermal diffusion.** Kincaid, J.M.; Cohen, E.G.D.; Lopez de Haro, M. (Thermophysics Division, National Bureau of Standards, Gaithersburg, Maryland 20899). *Journal of Chemical Physics;* **86**: No. 2, 963-975(15 Jan 1987).

Using the revised Enskog theory we derive equations for the thermal diffusion ratios k/sub T//sub i/ and thermal diffusion factors α/sub i//sub j/ of multicomponent hard-sphere mixtures for systems in mechanical equilibrium. The first ten Enskog approximations to the thermal diffusion factor α/sub i//sub j/[N] (N = 1,2,...,10) are evaluated numerically for a variety of system parameter choices appropriate to binary and ternary mixtures. We find that the first Enskog approximation does not vanish; the sequence of Enskog approximations converges most rapidly when the mass of the spheres are nearly equal. The seventh Enskog approximation was estimated to lie within about 1% of the exact value for all choices of system parameters. A comprehensive numerical study of the properties of the thermal diffusion factor for binary mixtures is given, including special mixtures such as the dusty gas, the Lorentz, quasi-Lorentz and Rayleigh gases, and isotopic mixtures. Particular emphasis is placed on showing how the properties of α_{12} change as the density is increased. The most striking difference between the low-density (Boltzmann) and high-density values for α_{12} is that the region of the mass ratio: diameter ratio plane for which α_{12} is either strictly positive or negative, as a function of composition, is much smaller at high densities. Also, at higher densities α_{12} is not a monotonic function of the mole fraction. For ternary mixtures in which two of the components are isotopes we show how the properties of the third component affect the separation of the two isotopes.

26248 **Direct correlation function of a one-dimensional ising model.** Borzi, C.; Ord, G.; Percus, J.K. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Journal of Statistical Physics;* **46**: No. 1, 51-66(Jan 1987).

The strictly finite range of the direct correlation function for a homogeneous nearest neighbor Ising chain is shown to persist in the presence of arbitary site-dependent coupling constants and an arbitrary external field. A method is developed to examine the range of the direct correlation function for many-neighbor interactions. It is found from numerical examples that, in general, third-neighbor and higher interactions induce long-range direct correlations, as does the presence of a field in the second-neighbor case.

26249 **Corrections to scaling for period doubling.** Mao, J.; Hu, B. (Center for Studies of Nonlinear Dynamics (affiliated with the University of California-San Diego), La Jolla Institute, La Jolla, California 92037). *Journal of Statistical Physics;* **46**: No. 1, 111-118(Jan 1987).

We have studied a muliple scaling which describes corrections to scaling. For the period doubling in one-dimensional dissipative maps, two-dimensional area-preserving maps, and four-dimensional symplectic maps, the multiple scaling is seen to be well-obeyed, and new scaling factors have been found. The multiple scaling is also seen to be a very powerful tool for searching for scaling behavior.

26250 **New method of analysis of the effect of weak colored noise in nonlinear dynamical systems.** Altares, V.; Nicolis, G. (Faculte des Sciences, Universite Libre de Bruxelles, 1050 Bruxelles, Belgium). *Journal of Statistical Physics;* **46**: No. 1, 191-206(Jan 1987).

A systematic method for obtaining the asymptotic behavior of a dynamical system forced by colored noise in the limit of small intensity is developed. It is based on the search of WKB solutions to the Fokker-Planck equation for the joint probability density of the system and noise, in which the perturbation expansion is continued to the first correction beyond the Hamiltonian-Jacobi limit. The method can be applied to noise with correlation time of order unity. It is illustrated on the normal form of a pitchfork bifurcation, where it is pointed out that additive noise can induce a shift of the most probable value. This prediction is confirmed by numerical simulation of the stochastic differential equations.

26251 **Randomly exact methods.** Doll, J.D.; Freeman, D.L. (Los Alamos National Lab., NM). *Science (Washington, D.C.);* **234**: 1356-1360(12 Dec 1986).

Important advances in the understanding of random processes have produced a variety of stochastic algorithms that offer unprecedented scope and utility in the study of physical systems.

These algorithms represent a departure from the usual philosophy inherent in the study of many-body problems and have a number of significant features. Chief among these features are simplicity, weak dependence on dimensionality, and ease of transition between classical and quantum-mechanical descriptions. These methods are also readily adapted for use on massively parallel computer architectures. These new stochastic methods represent a valuable addition to the tools available for the analysis of both equilibrium and time-dependent many-body problems.

26252 **Relativistic momentum space equations with applications to atomic and elementary particle physics.** Hardekopf, E.E. College Park, MD; Univ. of Maryland (1986). 159p. University Microfilms Order No. 86-28,981.

Thesis (Ph. D.).

Relativistic equal-time wave equations obtained from field theory which describe bound states of N Dirac particles inevitably involve free of external-field positive-energy projection operators Λ/sub +/(i). For $N > 2$ these operators are vital if the equations are to admit normalizable solutions. Such equations have been used in the past to obtain relativistic corrections to simple atomic systems, and to provide a theoretical basis for the Dirac-Hartree-Fock type of equations for many-electron atoms. These equations also find applications in elementary particle physics in describing bound states of quarks. Here a numerical study of such equations is initiated, avoiding an expansion in powers of v/c. The work is in momentum space, where the free projection operators are simple functions of p vector. Results are presented for both pure Coulomb and a Coulomb-plus-Breit potential for the atomic case, and for a pure Lorentz scalar in the linear potential case. In the atomic case a wide range of m_1/m_2 and coupling strength γ is studied and the $m_2 = \infty$ limit is compared with the Dirac equation. The magnitude of level shifts associated with virtual pair production in such two-body systems is discussed. For the linear potential, the relativistic eigenfunctions are used to study, in the absence of pair effects, the dipole amplitude of radiative transitions between bound states of charmonium.

26253 **Nonlinear natural engine: model for thermodynamic processes in mesoscale systems.** Wheatley, J.; Buchanan, D.S.; Swift, G.W.; Migliori, A.; Hofler, T. (Los Alamos National Lab., NM). *Proceedings of the National Academy of Sciences of the United States of America;* **82**: 7805-7809(Dec 1985).

To develop intuition on the possible application of concepts from thermodynamic heat engines to mesoscale systems, the authors have constructed and studied a model thermoacoustic heat engine. The model consists of a chain of coupled nonlinear acoustic vibrators in which the primary thermodynamic medium is argon gas, the secondary thermodynamic medium is constituted by solids bounding the gas, and frequencies are ca. 3 x 10^2 Hz. The nonlinear elements are the necks, made flexible by means of an oil-loaded DuPont Kapton film, of Helmholtz resonators. When the primary medium is driven uniformly by an acoustic driver at a frequency somewhat below the low-amplitude resonant frequency and at a high enough driving amplitude, stationary localized or solitary states appear irreversibly on the chain. These are characterized by a higher vibrational amplitude than that in surrounding vibrators, where the amplitude can decrease; by the appearance of deep subharmonics of the drive frequency, corresponding to driven low-frequency vibrations of the Kapton film-oil systems; and by the pumping of heat toward the localized states. Possible implications of these results for mesoscale systems consisting of chains of molecular vibrators are then discussed. 19 references, 3 figures.

26254 **Sensitivity of branch selection in nonequilibrium systems.** Kondepudi, D.K.; Prigogine, I.; Nelson, G. (Univ. of Texas, Austin). *Physics Letters [Section] A;* **111A**: No. 1-2, 29-32(26 Aug 1985). Contract AS05-81ER10947.

The branch selection process for the case of the general cubic in the presence of both additive and multiplicative noise is studied. If the bifurcation parameter passes slowly through the bifurcation point the system shows almost the same sensitivity as a system with no quadratic term. 10 references, 1 figure, 3 tables.

26255 **Transition of a coherent classical wave to phase incoherence.** Kaufman, A.N.; McDonald, S.W.; Rosengaus, E. (Lawrence Berkely Lab., CA). pp 217-225 of Chaotic behavior in quantum systems. Casati, G. (ed.). New York, NY; Plenum Publishing Corporation (1985).

A coherent wave may be characterized by a single-valued phase function. As the wave propagates, its rays twist and separate, causing its Lagrangian manifold k(x) to develop pleats. Thereby the phase becomes multivalued, and the wave may be termed incoherent. This process is analyzed by studying the local spectral density, which changes from a line spectrum to a continuous spectrum. 5 references, 3 figures.

26256 **One-dimensional approximations for a quadratic Ikeda map.** Carr, J.; Eilbeck, J.C. (Heriot-Watt Univ., Edinburgh, Scotland). *Physics Letters [Section] A;* **104A**: No. 2, 59-62(13 Aug 1984).

Some properties of the quadratic Ikeda map are reviewed. Various one-dimensional approximations to the map and its strange attractor are presented. 6 references, 3 figures, 1 table.

26257 **Asymptotic Poincare lemma and its applications.** Ziolkowski, R.W.; Deschamps, G.A. (Univ. of Illinois, Urbana). *SIAM Journal of Mathematical Analysis;* **15**: No. 3, 535-558(May 1984). Contract W-7405-ENG-48.

An asymptotic version of Poincare's lemma is defined and solutions are obtained with the calculus of exterior differential forms. They are used to construct the asymptotic approximations of multidimensional oscillatory integrals whose forms are commonly encountered, for example, in electromagnetic problems. In particular, the boundary and stationary point evaluations of these integrals are considered. The former is applied to the Kirchhoff representation of a scalar field diffracted through an aperture and simply recovers the Maggi-Rubinowicz-Miyamoto-Wolf results. Asymptotic approximations in the presence of other (standard) critical points are also discussed. Techniques developed for the asymptotic Poincare lemma are used to generate a general representation of the Leray form. All of the (differential form) expressions presented are generalizations of known (vector calculus) results. 14 references, 4 figures.

26258 **Storage-efficient method for construction of a Thiessen triangulation.** Cline, A.K.; Renka, R.L. (Univ. of Texas, Austin). *Rocky Mountain Journal of Mathematics;* **14**: No. 1, 119-139(Win 1984).

This paper describes a storage-efficient method and associated algorithms for constructing and representing a triangulation of arbitrarily distributed points in the plane. 16 references, 11 figures, 2 tables.

26259 **Resonant model interactions and adiabatic invariance for a nonlinear wave equation in a variable domain.** Kevorkian, J.; Li, H.K. (Univ. of Washington, Seattle). *Studies in Applied Mathematics;* 1-64(1984). Contract AM06-70RL02225.

The authors extend the technique of isolating and order reducing transformations for computing adiabatic invariants in finite-degree-of-freedom Hamiltonian systems to the case of the non-Hamiltonian systems to the case of the non-Hamiltonian modal representation of a wave equation with weak nonlinearities in a slowly varying domain. The authors exhibit the mechanism of resonant interactions for two or more normal modes whereby the associated actions change rapidly in a short period. In the Hamiltonian problem there are a number of global adiabatic invariants associated with each resonance. The authors derive conditions for which similar adiabatic invariants can be found for the non-Hamiltonian case. The results are then verified by extensive numerical computations. 11 figures, 10 references.

26260 **An algebraic approach to scattering and band structure problems.** Alhassid, Y. (A.W. Wright Nuclear Structure Lab., Yale Univ., New Haven, CT 06511). pp 337-347 of Group theoretical methods in physics. Zachary, W.W. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8405168—).

From International colloquium on group theoretical methods in physics; College Park, MD, USA (21 May 1984).

It is shown that both bound and scattering states of a class of potentials are related to the unitary representations of certain groups. For such systems the scattering matrix can be calculated in a completely algebraic way through the use of the Euclidean group to describe asymptotic behaviour. The band structures associated with a family of periodic potentials can also be obtained from the group theory. These results suggest that an algebraic approach to scattering and band structure problems similar to that applied to bound states is possible.

26261 Integrability properties of supersymmetric Yang-Mills fields and relations with other non-linear systems. Chau, L.L. (Physics Dept., Brookhaven National Lab., Upton, NY 11973). pp 3-15 of Group theoretical methods in physics. Zachary, W.W. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8405168—).

From International colloquium on group theoretical methods in physics; College Park, MD, USA (21 May 1984).

Integrable properties, i.e., existence of linear systems, infinite number of conservation laws, Riemann-Hilbert transforms, affine Lie algebra of Kac-Moody, and Bianchi-Backlund transformation, are discussed for the constraint equations of the supersymmetric Yang-Mills fields. For $N \geqq 3$ these constraint equations give equations of motion of the fields. These equations of motion reduce to the ordinary Yang-Mills equations as the spinor and scalar fields are eliminated. These understandings provide a possible method to solve the full Yang-Mills equations. Connections with other non-linear systems are also discussed.

26262 Isometries, dimensional reduction, and superunification. Mansouri, F.; Witten, L. (Physics Dept., Univ. of Cincinnati, Cincinnati, OH 45221). pp 502-505 of Group theoretical methods in physics. Zachary, W.W. Philadelphia, PA; World Scientific Pub. Co. (1984). (CONF-8405168—).

From International colloquium on group theoretical methods in physics; College Park, MD, USA (21 May 1984).

Dimensional reduction is carried out for space-times, with or without torsion, which admit a group, G, of isometries. The spectrum and the field equations are derived directly from the higher dimensional theory. A method of probing the extra dimensions is suggested.

26263 Full- and partial-range eigenfunction expansions for Sturm-Liouville problems with indefinite weights. Kaper, H.G.; Kwong, M.K.; Lekkerkerker, C.G.; Zettl, A. (Argonne National Lab., IL). *Proceedings - Royal Society of Edinburgh, Section A: Mathematical and Physical Sciences;* **98A**: 69-88(1984). Contract W-31-109-ENG-38.

This article is concerned with eigenvalue problems of the form $Au = \lambda Tu$ in a Hilbert space H, where A is a selfadjoint positive operator generated by a second-order Sturm-Liouville differential expression and T a selfadjoint indefinite multiplicative operator which is one-to-one. Emphasis is on the full-range and partial-range expansion properties of the eigenfunctions. 25 references.

26264 Application of the power-shift transformation. Beauchamp, J.J.; Kane, V.E. (Union Carbide Corp., Oak Ridge, TN). *Journal of Statistical Computation and Simulation;* **19**: 35-58(1984). Contract W-7405-ENG-26.

Some of the practical consequences of entertaining the power-shift transformation are examined for both analysis of variance and simple random sampling data. The appropriateness of different procedures for estimating the transformation parameters is also considered. Standard maximum likelihood (ml) estimation is shown not to be feasible for the joint estimation of the power-shift parameters. However, it is possible to compute local ml estimates for some problems, but special estimation methods may be necessary. An alternative weighted order statistic (wos) estimator is shown to be useful in some situations. Characteristics of ml and wos estimation for the power-shift transformation are examined by a Monte Carlo experiment. A Box and Cox (1964) example and several other data sets are used to illustrate the estimation procedures. 46 references, 5 figures, 1 table.

26265 Nature of some chaotic states for Duffing's equation. Chui, S.T.; Ma, K.B. (Univ. of Delaware, Newark). *Physical Review [Section] A: General Physics;* **26**: No. 4, 2262-2265(Oct 1982). Contract AC02-82ER12060.

The conventional picture of chaos consists of the coupling of a cascade of Fourier modes. Instead, the authors find that deep in the chaotic region of the driven, damped anharmonic oscillator, the states can be characterized very simply as the spontaneous generation of Fourier modes of random phases and small frequencies. This leads to a new and relatively simple way to calculate a measure to convert time averages to ensemble averages, as is normally done in statistical mechanics. 7 references, 2 figures.

26266 Note on minimizing the prediction error when the zeros are restricted to the unit circle. Goodman, D.M.; Miller, E.K. (Lawrence Livermore National Lab., CA). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Acoustics, Speech and Signal Processing;* **ASSP-30**: No. 3, 503-505(Jun 1982). Contract W-7405-ENG-48.

It is shown that the problem of minimizing the prediction error under the constraint that the zeros of the predictor polynomial be on the unit circle can be solved by using a modification of the Levinson algorithm. Consequences of this result are discussed. 13 references.

26267 Oscillation criteria for nonlinear Bianchi equations. Travis, C.C.; Yoshida, N. (Oak Ridge National Lab., TN). *Nonlinear Analysis;* **6**: No. 6, 625-636(1982). Contract W-7405-ENG-26.

The oscillatory behavior of solutions of characteristic initial value problems for the Bianchi operator L is examined. Bianchi extended the method of Riemann to linear partial differential equations of high order which are called Bianchi equations. Employing the Euler-Cauchy polygon method or Picard's method of successive approximations, several authors established existence and uniqueness theorems for boundary or initial value problems in nonlinear Bianchi in establishing comparison and oscillation theorems for characteristic initial value problems. The purpose of this paper is to obtain sufficient conditions for all solutions of $\mu L[\mu] \leqq 0$ satisfying suitable initial conditions to be oscillatory in Hilbert space.

70 FUSION ENERGY

REFER ALSO TO CITATION(S) 24895

26268 (DOE/ER/30079—T1) Benefit-analysis of accomplishments from the magnetic fusion energy (MFE) research program. Lago, A.M.; Weinblatt, H.; Hamilton, E.E. (Ecosometrics, Inc., Bethesda, MD (USA)). 31 Mar 1987. Contract AC01-86ER30079. 186p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE87008049.

This report presents the results of a study commissioned by the US Department of Energy's (DOE) Office of Program Analysis to examine benefits from selected accomplishments of DOE's Magnetic Fusion Energy (MFE) Research Program. The study objectives are presented. The MFE-induced innovation and accomplishments which were studied are listed. Finally, the benefit estimation methodology used is described in detail. The next seven chapters document the results of benefit estimation for the MFE accomplishments studied.

26269 (DOE/S—0055) Report of the Technical Panel on Magnetic Fusion of the Energy Research Advisory Board. (USDOE Energy Research Advisory Board, Washington, DC. Technical Panel on Magnetic Fusion). Nov 1986. 72p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87006193.

This report on the Department of Energy's Magnetic Fusion Energy program was requested by Secretary of Energy John S. Herrington, in compliance with the Magnetic Fusion Energy Act of 1980 (Appendix H). The Panel finds that fusion energy continues to be an attractive energy source of great potential for the future, and that the Magnetic Fusion Energy program continues to make substantial progress toward the development of fusion energy. In addition, fusion R & D continues to make valuable contributions to the national science and technology base. These factors fully justify the substantial DOE expenditures in fusion R & D. The Panel endorses the MFE program's direction, strategy, and plan, and recognizes the importance and timeliness of proceeding with a burning plasma experiment, such as the proposed Compact Ignition Tokamak (CIT) experiment. Because the program has been narrowed substantially due to budget reductions, the Panel recommends that incremental funds be provided for the proposed CIT in order to maintain the overall structure of the program. The program has made a good start toward obtaining international collaboration on a major device, an Engineering Test Reactor. The Panel views this as an opportunity for the United States and its partners to save billions of dollars, in the long run, on the development of fusion energy and recommends that DOE proceed with the negotiations needed to reach this goal.

7001 Plasma Research

REFER ALSO TO CITATION(S) 25631, 26043, 26061, 26072, 26228

26270 **(ANL/FPP/TM—213) Noninductive current drive for INTOR: A comparison of four driver options.** Ehst, D.A.; Evans, K. Jr.; Mikkelsen, D.R.; Ignat, D.W.; Mau, T.K. (Argonne National Lab., IL (USA); Princeton Univ., NJ (USA). Plasma Physics Lab.; California Univ., Los Angeles (USA)). Jan 1987. Contract W-31109-ENG-38. 83p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007948.

The current drive power and normalized efficiency are calculated for the INTOR tokamak, including spatial profiles of the plasma and current density. Current drive requirements are computed for purely steady state operation with no electromotive force and also in the presence of a reversed emf typical of start-up or transformer recharging. Results are obtained for lower-hybrid-waves, high frequency fast waves, low frequency fast waves and neutral beam injection.

26271 **(CONF-870267—1-Vugraphs) TF ripple loss of fast alphas.** Hively, L.M. (Oak Ridge National Lab., TN (USA)). 6 Feb 1987. Contract AC05-84OR21400. 22p. NTIS, PC A02. File Number DE87006629.

From US/Japan exchange (Q70) on next step machine design workshop; Livermore, CA, USA (23 Feb 1987).

Viewgraphs from this presentation are given. The topics covered included: (1) previous work on background plasma, fast ion transport - MeV alphas, neutral beam ions, and rf heated tail ion; (2) important results; (3) alpha loss calculations; and (4) unresolved issues. (MOW)

26272 **(CONF-870302—89) Operation of the ORNL ECR [Electron Cyclotron Resonance] source.** Meyer, F.W.; Hale, J.W. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 3p. NTIS, PC A02. File Number DE87007927.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

The ORNL ECR multicharged ion source, dedicated for studying the atomic physics interactions of multicharged ions with atoms, ions, electrons, and surfaces has been in operation since 1984. High charge state ion beams ranging from fully stripped light ions (up to Ne) to up to 40% stripped heavy ions (A ~ 200) have bee produced. Ion beams of the metallic elements developed to date include Cr, Fe, Ni, Ta, and Au, and are obtained by the use of a solid feed technique.

26273 **(DOE/ER/53207—2) Neoclassical diffusion due to trapping/detrapping orbits in stellarators: Annual progress report for period September 15, 1986-September 14, 1987.** Cary, J.R. (Colorado Univ., Boulder (USA)). Apr 1987. Contract FG02-85ER53207. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007858.

In the past year we have made progress on several issues of stellarator transport. A practical invariant of the motion for stellarators based on the fact the stellarators have small rotational transform per field period was developed. The previous general analysis of separatrix crossing by the principal investigator was applied to calculate transition rates between states of particles in stellarators. Numerical calculations to check these rate calculations were begun. The significance of correlations between separatrix crossings was discovered. A small-aspect-ratio six-field-period stellarator was designed. The effects of average curvature on collisionless tearing and drift modes were clarified. The importance of quantum effects in macroscopic systems was demonstrated. Seven publications dealing with these issues are attached as appendices.

26274 **(DOE/ET/51013—205) RF heating and current drive experiments on the Alcator C and Versator II tokamaks.** Porkolab, M.; Bonoli, P.; Chen, K.I.; Fiore, C.; Granetz, R.; Griffin, D.; Gwinn, D.; Knowlton, S.; Lipschultz, B.; Luckhardt, S.C. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Nov 1986. Contract AC02-78ET51013. 22p. (PFC/CP—86-19; IAEA-CN—47/F-II-2; CONF-861106—24). NTIS MF A01; 2; GPO Dep. File Number DE87007928.

From IAEA international conference on plasma physics and controlled nuclear fusion research; Kyoto, Japan (12 Nov 1986).

Lower hybrid heating and current drive experiments on the Alcator C tokamak (R = 0.64 m, a = 0.165 m, molybdenum limiters) were performed at a frequency of 4.6 GHz with net injected rf powers up to P/sub rf/ ≦ 1.5 MW. Recent experiments have focused on energy confinement studies in lower hybrid current-driven (LHCD) and LHRF heated Ohmic discharges, and sawtooth stabilization in combined LHCD-OH driven discharges at densities n-bar/sub e/ ≦ 1.4 x 10^{20} m^{-3}. Ion Bernstein wave heating experiments were also carried out in Alcator C at a frequency of f = 183 MHz at power levels P/sub rf/ ≦ 200 kW. Significant heating (ΔT/sub i/ ≦ 400 eV) was observed at ω/ω/sub CH/ ≃ 1.5, 2.5 and ω/ω/sub CD/ ≃ 2.5 at densities n-bar/sub e/ ≃ 1 x 10^{20} m^{-3}. In the Versator II tokamak, particle confinement improvement (by factors of ≈2) was observed in the presence of 2.45 GHz lower hybrid current drive.

26275 **(DOE/ET/53064—T10) Plasma theory and simulation: Quarterly progress report Nos. 3 and 4, July 1, 1985-December 31, 1985.** Birdsall, C.K. (California Univ., Berkeley (USA). Electronics Research Lab.). 1985. Contract AS03-76ET53064. 57p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87008192.

Our group uses theory and simulation as tools in order to increase the understanding of plasma instabilities, heating, transport, plasma-wall interaction an large potentials in plasmas. We also work on the improvement of simulation both theoretically and practically.

26276 **(DOE/ET/53088—261) Effective diffusion in laminar convective flows.** Rosenbluth, M.N.; Berk, H.L.; Doxas, I.; Horton, W. (Texas Univ., Austin (USA). Inst. for Fusion Studies). Mar 1987. Contract FG05-80ET53088. 42p. (IFSR—261). NTIS, PC A03/MF A01; GPO Dep. File Number DE87008054.

The effective diffusion coefficient D* of a passive component, such as test particles, dye, temperature, magnetic flux, etc., is derived for motion in periodic two-dimensional incompressible convective flow with characteristic velocity v and size d in the presence of an intrinsic local diffusivity D. Asymptotic solutions for effective diffusivity D*(P) in the large P limit, with P ~ vd/D, is shown to be of the form D* = cDP/sup 1/2/ with c being a coefficient that is determined analytically. The constant c depends on the geometry of the convective cell and on an average of the flow speed along the separatrix. The asymptotic method of evaluation applies to both free boundary and rough boundary flow patterns and it is shown that the method can be extended to more complicated patterns such as the flows generated by rotating cylinders, as in the problem considered by Nadim, Cox, and Brenner [J. Fluid Mech., 164: 185 (1986)]. The diffusivity D* is readily calculated for small P, but the evaluation for arbitrary P requires numerical methods. Monte Carlo particle simulation codes are used to evaluate D* at arbitrary P, and thereby describe the transition for D* between the large and small P limits.

26277 (DOE/ET/53088—266) **Hamiltonian four-field model for nonlinear tokamak dynamics.** Hazeltine, R.D.; Hsu, C.T.; Morrison, P.J. (Texas Univ., Austin (USA). Inst. for Fusion Studies). Feb 1987. Contract FG05-80ET53088. 31p. (IFSR—266). NTIS, PC A03/MF AO1; 1; GPO Dep. File Number DE87007585.

The Hamiltonian four-field model is a simplified description of nonlinear tokamak dynamics that allows for finite ion Larmor radius physics as well as other effects related to compressibility and electron adiabaticity. Much simpler than a rigorous or even reduced description of the same physics, it still preserves essential features of the underlying exact dynamics. In particular, because it is a Hamiltonian dynamical system it conserves the appropriate Casimir invariants, as well as avoiding implicit, unphysical dissipation. Here the model is derived and interpreted, its Hamiltonian nature is demonstrated, and its constants of motion are extracted.

26278 (DOE/ET/53088—271) **Reduced fluid descriptions of toroidally confined plasma with finite ion temperature effects.** Hsu, C.T. (Texas Univ., Austin (USA). Inst. for Fusion Studies). Mar 1987. Contract FG05-80ET53088. 203p. (IFSR—271). Institute for Fusion Studies, Univ. of Texas, Austin, TX 78712. File Number TI87007386.

Fluid descriptions of toroidally confined plasma with FLR effects are studied, based on a generalized, energy conserving, self-consistent, nonlinear reduced fluid model (HHM). The model, derived via a fluid approach starting from moment equations, differs from Braginskii's fluid system in retaining O(rho/sub i/^{2}) terms (where rho/sub i/ is the ion gyroradius) and most of the non-ideal effects. Hence, many of the well-known reduced fluid models can be reproduced from HHM by simply specifying scales of some parameters such as rho/sub i/ and β. On the other hand, a Pade approximation of the full FLR system, obtained from the simplified version of HHM, is also presented.

26279 (GA-A—18719) **Classical dissipation and transport.** Hinton, F.L. (GA Technologies, Inc., San Diego, CA (USA)). Jan 1987. Contract AC03-84ER53158. 38p. (CONF-870247—2). NTIS, PC A03/MF A01; GPO Dep. File Number DE87005832.

From International Rosenbluth symposium on dynamics of particles and plasmas; Austin, TX, USA (2 Feb 1987).

This paper reviews the subject of classical and neoclassical transport, including Fokker-Planck theory, with an emphasis on Marshall Rosenbluth's contributions. He has worked with many people on transport and I was fortunate to have been one of them. The paper is organized into four main parts, dealing with plasma kinetic theory, classical transport, neoclassical transport, and the present state of the subject.

26280 (N—87-13307) **Space plasma research. Final report, August 1980-August 1986.** Comfort, R.H.; Horwitz, J.L. (Alabama Univ., Huntsville (USA)). Sep 1986. 26p. (NASA-CR—178965; NAS—1.26:178965). NTIS, PC A03/MF A01.

Four basic areas were covered: development of analysis techniques and software and numerical simulations; data analysis and interpretation; spacecraft sheath studies; and laboratory studies. The important details were documented in terms of either appropriate software documentation or publication in referred publication, conference proceeding and technical reports. The major accomplishments are summarized, followed by a chronological listing of the publications and presentations which resulted from the research.

26281 (N—87-16614) **Measurements of plasma density and turbulence near the shuttle orbiter.** Tribble, A.; Dangelo, N.; Murphy, G.; Pickett, J. (Iowa Univ., Iowa City (USA)). Jan 1987. 12p. (NASA-CR—180102; NAS—1.26:180102). NTIS, PC A02/MF A01.

In August 1985 the University of Iowa's Plasma Diagnostics Package was used in the Spacelab 2 mission to study the plasma environment near the shuttle orbiter. Measurements of the plasma density and the percentage density fluctuations yielded information about the structure of the orbiter's wake. These data appear to be in general agreement with previous shuttle results and with laboratory observations of plasma flow-body interactions.

26282 (ORNL—6090/V5) **Collisions of carbon and oxygen ions with electrons, H, H_2 and He: Volume 5.** Phaneuf, R.A.; Janev, R.K.; Pindzola, M.S. (Oak Ridge National Lab., TN (USA); Belgrade Univ. (Yugoslavia). Inst. za Fiziku; Auburn Univ., AL (USA)). Feb 1987. Contract AC05-84OR21400. 631p. NTIS, PC A99. File Number DE87007880.

This report provides a handbook for fusion research of recommended cross-section and rate-coefficient data for collisions of carbon and oxygen ions with electrons, hydrogen atoms and molecules, and helium atoms. Published experimental and theoretical data have been collected and evaluated, and recommended data are presented in tabular, graphical, and parametrized form. Processes considered include exciation, ionization, and charge exchange at collision energies appropriate to applications in fusion-energy research.

26283 (ORNL—6234, pp 2.3-2.36) **Atomic physics and plasma diagnostics development.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

The activities within the Atomic Physics and Diagnostics Development Program are divided among atomic collisions research, data compilation, and plasma diagnostics development. The majority of this research is supported through the ORNL Fusion Program but is carried out within the Physics Division. The atomic collisions research focuses on inelastic processes that are important for determining the energy balance and impurity transport in high-temperature plasmas and for diagnostic measurements. Two major recent experimental developments have enhanced their ability to address fusion-related atomic collision processes. First, the capability of their electron cyclotron resonance (ECR) multicharged ion source to produce highly charged ions from metals, such as iron, has been developed and implemented for crossed-beams experiments. Second, the successful implementation of a new charge analyzer in the electron-ion crossed-beams experiment increases the maximum charge state for ionization cross-section measurements from 6 to 15, allowing full advantage to be taken of the charge-state capabilities of the ECR source. The plasma diagnostics program concentrates on the development of advanced diagnostics for existing and future magnetic fusion experiments, relying primarily on optical and laser technology. The current emphasis is on the application of infrared lasers to the diagnostics of ignited multicomponent plasmas. A technique being developed uses Thomson scattering of a pulsed carbon dioxide laser beam to measure the density and velocity distribution of fusion-product alpha particles.

26284 (ORNL—6234, pp 3.1-3.58) **Plasma theory.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

Fundamental contributions have been made to the theoretical physics of plasma confinement devices, general plasma areas, and related fields. These include: nonlinear analysis and turbulence theory developed for studying confinement physics has applications as well in solar plasma and reactor confinement physics; comprehensive theory for the complicated physical and mathematical problem of neoclassical (collisional) transport in the fully three-dimensional (3-D) magnetic structures of stellarator confinement devices; procedures to analyze the full wave rf field problem, eliminating the common geometrical optics approximation - the validity of which is debatable at best for present plasma confinement experiments; and stability theory brought to broad maturity by development of nonlinear turbulence models supplemented by a neoclassical MHD model, which begins to incorporate the kinetics of long mean-free-path behavior. Strong support has been provided for the US effort to define and design a fusion ignition device, the Compact Ignition Tokamak (CIT), at a size consistent with credible funding requirements. Essential analysis of the fusion burn dynamics has been carried out, including determination of the tolerance of the preconceptual design to effects that degrade confinement. A novel operating scenario has been suggested, using ramped fields and currents to establish a hot plasma discharge within the pulse time limits defined by cost factors. In addition theoretical contributions were an essential ingredient in the development of several innovative plasma confinement concepts.

26285 (PPPL—2408) Satellite spectra of heliumlike nickel. Hsuan, H.; Bitter, M.; Hill, K.W.; von Goeler, S. Grek, B.; Johnson, D.; Johnson, L.C.; Sesnic, S.; Bhalla, C.P.; Karim, K.R. (Princeton Univ., NJ (USA). Plasma Physics Lab.; Kansas State Univ., Manhattan (USA). Dept. of Physics; Observatoire de Nice, 06 (France)). Feb 1987. Contract AC02-76CH03073. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008065.

Spectra of heliumlike nickel, NiXXVII, have been observed from Tokamak Fusion Test Reactor (TFTR) plasmas with a high resolution crystal spectrometer. The experimental arrangement permits simultaneous observation of the heliumlike resonance line, the intercombination and forbidden lines, and all the associated satellites due to transitions $1s^2nl$ - $1s2l'nl''$ with $N \geqq 2$. Relative wavelengths and line intensities can thus be determined very accurately. The observed spectral data are in good agreement with results from the present Hartree-Fock-Slater atomic model calculations and predictions from the Z-expansion method.

26286 (PPPL—2410) A spectroscopic study of impurity behavior in neutral-beam and ohmically heated TFTR discharges. Stratton, B.C.; Ramsey, A.T.; Boody, F.P.; Bush, C.E.; Fonck, R.J.; Groenbner, R.J.; Hulse, R.A.; Richards, R.K.; Schivell, J. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 56p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE87008073.

Quantitative spectroscopic measurements of Z/sub eff/, impurity densities, and radiated power losses have been made for ohmic- and neutral-beam-heated TFTR discharges at a plasma current of 2.2 MA and toroidal field of 4.7 T. Variations in these quantities with line-average plasma density (anti n/sub e/) and beam power up to 5.6 MW are presented for discharges on a graphite movable limiter. A detailed discussion of the use of an impurity transport model to infer absolute impurity densities and radiative losses from line intensity and visible continuum measurements is given. These discharges were dominated by low-Z impurities with carbon having a considerably higher density than oxygen, except in high-anti n/sub e/ ohmic discharges, where the densities of carbon and oxygen were comparable. Metallic impurity concentrations and radiative losses were small, resulting in hollow radiated power profiles and fractions of the input power radiated being 30 to 50% for ohmic heating and 30% or less with beam heating. Spectroscopic estimates of the radiated power were in good agreement with bolometrically measured values. Due to an increase in the carbon density, Z/sub eff/ rose from 2.0 to 2.8 as the beam power increased from 0 to 5.6 MW, pointing to a potentially serious dilution of the neutron-producing plasma ions as the beam power increased. Both the low-Z and metallic impurity concentrations were approximately constant with minor radius, indicating no central impurity accumulation in these discharges.

26287 (PPPL—2411) Measurement of the local particle diffusion coefficient in a magnetized plasma. Meyerhofer, D.D.; Levinton, F.M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008072.

Local impurity particle diffusion coefficients have been measured in a low temperature plasma by the injection of test particles at the center of the plasma. The injection is accomplished by a high voltage discharge between two small graphite electrodes on a probe. The probe can be located anywhere in the plasma. The diffusion is observed spectroscopically. An analysis of the spatial and temporal evolution of the CII radiation from the carbon discharge can determine the parallel and perpendicular diffusion of the impurity ions. Results with the diagnostic have been obtained in the Proto S-1/C spheromak. The measured value of the diffusion coefficient in the afterglow plasma is in good agreement with classical predictions.

26288 (PPPL—2412) Theory of resistive magnetohydrodynamic instabilities excited by energetic-trapped particles in large-size tokamaks. Biglari, H.; Chen, L.; White, R.B. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008071.

It is shown that, in present-day large-size tokamaks, finite resistivity modifies qualitatively the stability properties of magnetohydrodynamic instabilities resonantly excited by the unfavorable processional drift of energetic-trapped particles, i.e., the so-called "fishbone"-type instabilities. Specifically, it is found that (1) the $n = 1$ energetic-trapped particle-induced internal kink ("fishbone") instability is strongly stabilized by resistive dissipation and (2) finite resistivity lowers considerably the threshold conditions for resonant excitations of high-n ballooning/interchange modes. The possibility of exciting fishbones by alpha particles in ignition experiments is also considered.

26289 (PPPL—2413) Anisotropic pressure tokamak equilibrium and stability considerations. Salberta, E.R.; Grimm, R.C.; Johnson, J.L.; Manickam, J.; Tang, W.M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 39p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008064.

Investigation of the effect of pressure anisotropy on tokamak equilibrium and stability is made with an MHD model. Realistic perpendicular and parallel pressure distributions, P/sub perpendicular/(psi,B) and P/sub parallel/(psi,B), are obtained by solving a one-dimensional Fokker-Planck equation for neutral beam injection to find a distribution function f(E, v/sub parallel//v) at the position of minimum field on each magnetic surface and then using invariance of the magnetic moment to determine its value at each point on the surface. The shift of the surfaces of constant perpendicular and parallel pressure from the flux surfaces depends strongly on the angle of injection. This shift explains the observed increase or decrease in the stability conditions. Estimates of the stabilizing effect of hot trapped ions indicates that a large fraction must be nonresonant and thus decoupled from the bad curvature before it becomes important.

26290 (PPPL—2414) Plasma transport in a compact ignition tokamak. Singer, C.E.; Ku, L.P; Bateman, G. (Illinois Univ., Urbana (USA); Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 35p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008068.

Nominal predicted plasma conditions in a compact ignition tokamak are illustrated by transport simulations using experimentally calibrated plasma transport models. The range of uncertainty in these predictions is explored by using various models which have given almost equally good fits to experimental data. Using a transport model which best fits the data, thermonuclear ignition occurs in a Compact Ignition Tokamak design with major radius 1.32 m, plasma half-width 0.43 m, elongation 2.0, and toroidal field and plasma current ramped in six seconds from 1.7 to 10.4 T and 0.7 to 10 MA, respectively. Ignition is facilitated by 20 MW of heating deposited off the magnetic axis near the ^3He minority cyclotron resonance layer. Under these conditions, sawtooth oscillations are small and have little impact on ignition. Tritium inventory is minimized by preconditioning most discharges with deuterium. Tritium is injected, in large frozen pellets, only after minority resonance preheating. Variations of the transport model, impurity influx, heating profile, and pellet ablation rates, have a large effect on ignition and on the maximum beta that can be achieved.

26291 (PPPL—2415) Simulation of a compact ignition tokamak discharge (CIT-2L). Stotler, D.P.; Bateman, G. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008067.

A reference simulation of a compact ignition tokamak (CIT) limiter discharge is carried out using the 1-1/2-D BALDUR transport code. The parameters for the discharge are as in the CIT-2L design; these parameters are described here, and the results of the simulation are discussed. It is found that plasma ignition can be reached and sustained within the specified constraints.

26292 **(PPPL—2416) Current relaxation time scales in toroidal plasmas.** Mikkelsen, D.R. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 30p. NTIS, PC A03/MF 01; 1; GPO Dep. File Number DE87008074.

An approximate normal mode analysis of plasma current diffusion in tokamaks is presented. The work is based on numerical solutions of the current diffusion equation in cylindrical geometry. Eigenvalues and eigenfunctions are shown for a broad range of plasma conductivity profile shapes. Three classes of solutions are considered which correspond to three types of tokamak operation. Convenient approximations to the three lowest eigenvalues in each class are presented and simple formulae for the current relaxation time scales are given.

26293 **(PPPL—2418) Microinstability-based models for confinement properties and ignition criteria in tokamaks.** Tang, W.M.; Bishop, C.M.; Coppi, B.; Kaye, S.M.; Perkins, F.W.; Redi, M.H.; Rewoldt, G. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008070.

This paper reports on results of theoretical studies dealing with: (1) the use of microinstability-based thermal transport models to interpret the anomalous confinement properties observed in key tokamak experiments such as TFTR and (2) the likely consequences of the presence of such instabilities for future ignition devices. Transport code simulations using profile-consistent forms of anomalous thermal diffusivities due to drift-type instabilities have yielded good agreement with the confinement times and temperatures observed in TFTR under a large variety of operating conditions including pellet-fuelling in both ohmic- and neutral-beam-heated discharges. With regard to achieving an optimal ignition margin, the adverse temperature scaling of anomalous losses caused by drift modes leads to the conclusion that it is best to operate at the maximum allowable density while holding the temperature close to the minimum value required for ignition.

26294 **(PPPL—2423) Numerical solution of three-dimensional magnetic differential equations.** Reiman, A.H.; Greenside, H.S. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007976.

A computer code is described that solves differential equations of the form B . del f = h for a single-valued solution f, given a toroidal three-dimensional divergence-free field B and a single-valued function h. The code uses a new algorithm that Fourier decomposes a given function in a set of flux coordinates in which the field lines are straight. The algorithm automatically adjusts the required integration lengths to compensate for proximity to low order rational surfaces. Applying this algorithm to the Cartesian coordinates defines a transformation to magnetic coordinates, in which the magnetic differential equation can be accurately solved. Our method is illustrated by calculating the Pfirsch-Schlueter currents for a stellarator.

26295 **(UCB/ERL-M—86/94) Linear magnetized plasma response to an oblique electrostatic wave.** Lawson, W.S. (California Univ., Berkeley (USA). Electronics Research Lab.). 15 Dec 1986. Contract AS03-76ET53064. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008194.

The linear response of a spatially periodic magnetized Vlasov plasma distribution function is computed to second order in the electric field. The results for a specific electric field are then compared with the results of computer simulation for different amplitudes of the electric field. Both trapping and resonant heating are observed, and both appear to contribute (for the chosen parameters) to limiting the validity of linear theory at larger electric field amplitudes.

26296 **(UCB/ERL-M—87/14) Computer simulation of bounded plasma systems.** Lawson, W.S. (California Univ., Berkeley (USA). Electronics Research Lab.). 5 Mar 1987. Contract AS03-76ET53064. 39p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008193.

The physical and numerical problems of kinetic simulation of a bounded electrostatic plasma system in one planar dimension are examined, and solutions to them are presented. These problems include particle absorption, reflection and emission at boundaries, the solution of Poisson's equation under non-periodic boundary conditions, and the treatment of an external circuit connecting the boundaries. Some comments are also made regarding the problems of higher dimensions. The methods which are described here are implemented in a code named PDW1, which is available from Professor C.K. Birdsall, Plasma Theory and Simulation Group, Cory Hall, University of California, Berkeley, CA 94720.

26297 **(UCID—21033) Comments on ECH current drive by asymmetric heating around the median plane (GA Technologies report No. GA-A18656, October 1986) by Tihiro Ohkawa.** Nevins, W.M.; Cohen, R.H.; Lodestro, L.L. (Lawrence Livermore National Lab., CA (USA)). 30 Mar 1987. Contract W-7405-ENG-48. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008341.

In a recent GA report Ohkawa describes a novel electron cyclotron current-drive (ECCD) scheme. Ohkawa finds a net toroidal plasma current driven by "up-down" asymmetries in the electron pressure anisotropy, i.e., differences in p/sub perpendicular/ - p/sub parallel/ evaluated at the same absolute value of B between the top and bottom half of the poloidal cross-section. Such up-down asymmetries are associated with the s-dependent, first order in nu/ω/sub b/ part of the electron distribution function (s is distance along a magnetic field line). The current-drive efficiency estimated by Ohkawa is competitive with other rf current-drive schemes. Ohkawa's scheme is attractive because it appears that this scheme can produce an rf-driven current even when the electron-cyclotron power is dissipated on trapped electrons; and the scheme requires no selectivity in the sign of the parallel velocity of the electrons heated by the electron cyclotron wave. In sections I through III of this memo we analyze the current-drive calculation presented by Ohkawa. We conclude that, in the limit of long mean-free-path appropriate to current tokamak experiments and tokamak reactors, the current Ohkawa attempts to compute from a fluid model is a neoclassical correction to the Fisch-Boozer current. Neoclassical effects that give rise to corrections of this sort were first pointed out by Ohkawa in an earlier paper on ECH current drive. These neoclassical effects (which are associated with magnetic field variations and trapped particles) have been treated more accurately by using a kinetic rather than fluid theory in several recent papers. They are important because they can reduce the ECCD efficiency below the level computed by Fisch and Boozer.

26298 **Use of multilayer targets to inject trace elements into laser-produced plasma.** Zigler, A.; Kolbe, J.; Lee, R.W. (University of California, Lawrence Livermore National Laboratory, P. O. Box 808/L-23, Livermore, California 94550). *Applied Physics Letters;* **50**: No. 17, 1133-1134(27 Apr 1987). Contract W-7405-ENG-48.

The use of multilayer target with predrilled holes to inject trace elements into laser-produced plasma is presented. The tracer plasma obtained shows a smaller source size and reduced opacity compared to a plasma target. The preparation and alignment of the proposed target are extremely simple.

26299 **Numerical modeling of lower hybrid heating and current drive.** Valeo, E.J.; Eder, D.C. (Plasma Physics Laboratory, Princeton University, P.O. Box 451, Princeton, New Jersey 08544). *Journal of Computational Physics;* **69**: No. 2, 341-361(Apr 1987).

The generation of currents in toroidal plasma by application of waves in the lower hybrid frequency range involves the interplay of several physical phenomena which include: wave propagation in toroidal geometry, absorption via wave-particle resonances, the quasilinear generation of strongly nonequilibrium electron and ion distribution functions, and the self-consistent evolution of the current density in such a nonequilibrium plasma. We describe a code, LHMOD, which we have developed to treat these aspects of current drive and heating in tokamaks. We present results obtained by applying the code to a computation of current ramp-up and to an investigation of the possible importance of minority hydrogen absorption in a deuterium plasma as the "density limit" to current drive is approached. copyright 1987 Academic Press, Inc.

26300 Plasma heating through a supercritical oblique collisionless shock. Lembege, B.; Dawson, J.M. (Centre de Recherches en Physique de l'Environnement Terrestre et Planetaire/Centre National d'Etudes des Telecommunications, 92131 Issy-les-Moulineaux, France). *Physics of Fluids;* **30**: No. 4, 1110-1114(Apr 1987).

Electron and ion dynamics are investigated through particle simulation of a supercritical oblique collisionless shock. As θ deviates from 90°, ions are accelerated and trapped in the electrostatic wells and later become detrapped; this results in strong ion heating perpendicular to B_0. Below a critical angle θ/sub t//sub e/ electrons are strongly energized along B_0, and heated. A large parallel electron current builds up and induces new transverse electromagnetic components in the ramp of the shock. For weaker angles, ion heating vanishes below a second critical angle θ/sub t//sub i/.

26301 Neoclassical transport coefficients for finite-aspect-ratio and bean-shaped tokamak plasmas. Crume E.C. Jr.; Beasley C.O. Jr.; Hirshman, S.P.; van Rij, W.I. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physics of Fluids;* **30**: No. 4, 1152-1159(Apr 1987). Contract AC05-84OR21400.

Numerically calculated tokamak equilibria are used to compute banana-plateau transport coefficients for finite-aspect-ratio, finite-beta plasmas. Calculations are presented for the Spherical Torus Experiment (STX) (NTIS Document No. DE 86004663) and the Princeton Beta Experiment (PBX) (NTIS Document No. DE 86011173). In STX, the poloidal variation of Bequivalentchemical bondBchemical bond over a magnetic surface tends to be reduced in regions of large major radius R. The reduction of radial transport caused by this quasiomnigeneous condition is offset by increased drifts and trapping probabilities for smaller R. Thus the modulation Δ = (B/sub max/-B/sub min/)/(B/sub max/+B/sub min/) on a magnetic surface becomes the critical parameter determining neoclassical transport. In PBX, the bean-shaped topology of the magnetic surfaces leads to the presence of multiple magnetic wells. Numerical calculations confirm that analytic calculations of neoclassical transport based on the total fraction of circulating particles are valid even when geometrically distinct classes of trapped particles are present.

26302 Plasma current ramp-up and Ohmic-heating transformer recharging experiments using lower-hybrid waves on a tokamak. Takase, Y.; Knowlton, S.; Porkolab, M. (Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physics of Fluids;* **30**: No. 4, 1169-1176(Apr 1987).

Plasma current ramp-up by lower-hybrid waves in a high-density regime (n-bar/sub e/approx. >1 x 10^{19} m^{-3}) is investigated on the Alcator C tokamak [Nucl. Fusion 25, 1127 (1985)]. A time-averaged conversion efficiency (W-italic-dot-P/sub ext/)/P/sub rf/ of over 15% has been obtained at a density of n-bar/sub e/ $\simeq$1 x 10^{19} m^{-3}, where W is the poloidal field energy and P/sub ext/ is the external inductive power. The maximum conversion efficiency obtainable is lower at higher densities. Ramp-up rates of over 1 MA/sec were obtained when rf current ramp-up is applied to an Ohmically maintained plasma. Lower-hybrid current drive can also be used to maintain the plasma while recharging the Ohmic-heating transformer. The conversion efficiency of 10% obtained during recharging is found to be comparable to that obtained during ramp-up under similar conditions.

26303 Model for the loop voltage of reversed field pinches. Jarboe, T.R.; Alper, B. (Culham Laboratory (UKAEA/Euratom Fusion Association), Abingdon, Oxon OX14 3DB, United Kingdom). *Physics of Fluids;* **30**: No. 4, 1177-1179(Apr 1987).

A simple model is presented that uses the concept of helicity balance to predict the toroidal loop voltage of reversed field pinches (RFP's). Data from the RFP's at Culham [Plasma Phys. Controlled Fusion 27, 1307 (1985)] are used to calibrate and verify the model. The model indicates that most of the helicity dissipation occurs in edge regions that are outside the limiters or in regions where field lines contact the walls. The value of this new interpretation to future RFP and spheromak experiments is discussed.

26304 Stochasticity about a poloidal divertor separatrix. Skinner, D.A.; Osborne, T.H.; Prager, S.C.; Park, W. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). *Physics of Fluids;* **30**: No. 4, 1218-1221(Apr 1987).

The stochasticization of the magnetic separatrix caused by the presence of a helical perturbation in a poloidal divertor tokamak is illustrated by a numerical computation that traces magnetic field lines.

26305 Tokamak equilibrium profile. Hsu, J.Y.; Chu, M.S. (GA Technologies Inc., San Diego, California 92138). *Physics of Fluids;* **30**: No. 4, 1221-1224(Apr 1987).

The fully relaxed magnetohydrodynamic (MHD) equilibrium is obtained by imposing nonideal MHD perturbations constrained by the total plasma current. The minimum energy state governed by Δ^*psi+C/sub F/ exp(psi/λ)+C/sub p/R^2 exp(5psi/4λ)= = 0 reveals properties of profile consistency, bifurcated solutions, and a loss of equilibrium condition. It predicts the transport coefficient peaked at the plasma edge and a unique current profile for given q_0 and q/sub l/.

26306 Liouville Theorem and accurate plasma simulation. Lewis, H.R.; Barnes, D.C.; Melendez, K.J. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Computational Physics;* **69**: No. 2, 267-282(Apr 1987).

The cold two-stream instability has been examined within the context of the one-dimensional Vlasov-Poisson model for three simulation methods. Two of the methods treat a continuum of particles; the third is the particle-in-cell method. The onset of noise in the simulations occurred near the time when the beams crossed or nearly crossed in the phase space, indicating a violation of Liousville's theorem or strong sensitivity of particle trajectories to initial conditions in the vicinity of the point of near crossing. Details of the underlying Hamiltonian structure of the particle dynamics appear to be important in achieving accurate plasma simulations. copyright 1987 Academic Press, Inc.

26307 Enhanced electron stochasticity from electrostatic waves in a sheared magnetic field. Robertson, J.A.; Horton, W.; Choi, D.I. (Institute for Fusion Studies, University of Texas at Austin, Austin, Texas 78712). *Physics of Fluids;* **30**: No. 4, 1059-1072(Apr 1987).

Electron motion in a single electrostatic wave in a sheared magnetic field is shown to become stochastic in the presence of a second wave at an amplitude well below that obtained from the overlapping pendulum resonance approximation. The enhanced stochasticity occurs for low parallel velocity electrons for which the parallel trapping motion from eE/sub parallel//m interacts strongly with the E x B trapping motion due to the presence of magnetic shear. The single-wave particle motion is given by a two-parameter family of one-degree-of-freedom Hamiltonians which bifurcate from a pendulum phase space to a topology with three chains of elliptic and hyperbolic fixed points separated in radius about the mode-rational surface. In the presence of a perturbing wave with a different helicity, electrons in the small parallel velocity regime become stochastic at an amplitude scaling as the fourth root of the wave potential. The results obtained for stochastic motion apply directly to the problem of the diffusion of electrons in drift waves.

26308 Collisional effects on the Weibel instability. Wallace, J.M.; Brackbill, J.U.; Cranfill, C.W.; Forslund, D.W.; Mason, R.J. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physics of Fluids;* **30**: No. 4, 1085-1088(Apr 1987).

The effects of electron Rutherford scattering on the Weibel instability are investigated using the implicit plasma simulation code

Ve-smcapsn-smcapsu-smcapss-smcaps [J. Comput. Phys. 46, 271 (1982); 63, 434 (1986)]. Collisions decrease the Weibel growth rate below the collisionless value, in agreement initially with simple linear theory. Likewise, collisions decrease the saturation level, in agreement with a magnetic trapping mechanism. When the collision rate exceeds the collisionless Weibel growth rate, the instability is suppressed altogether. The results provide benchmarks for analysis of proposed short-wavelength laser-fusion schemes.

26309 **Nonlocal effects on the drift cyclotron loss cone dispersion relation in cylindrical geometry.** Ferraro, R.D.; Littlejohn, R.G.; Sanuki, H.; Fried, B.D. (Department of Physics, University of California, Los Angeles, California 90024). *Physics of Fluids;* **30**: No. 4, 1115-1122(Apr 1987).

In carrying out a nonlocal analysis of drift cyclotron loss cone (DCLC) modes in a cylindrically symmetric plasma, a new dispersion relation branch not described by local theories has been found. The model assumes a low-β plasma column with a Gaussian density profile in a uniform magnetic field. The exact k-space integral equation is solved using a Laguerre polynomial decomposition of the eigenfunctions. It is these new modes that couple with the diamagnetic drift wave to form unstable DCLC modes, a phenomenon not predicted by local theory. The existence of these modes requires a proper treatment of the spatial variation of the equilibrium distribution function describing the ions.

26310 **Diamagnetic stability limit for a hot particle annulus in a plasma.** Berk, H.L.; Zhang, Y.Z. (Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712-1060). *Physics of Fluids;* **30**: No. 4, 1123-1136(Apr 1987).

The stability of a hot particle annulus in a mirror cell at arbitrary drift reversal is analyzed by using a cylindrical model with embedded currents that simulate the role of field line curvature in actual mirror experiments. New effects are included by taking into account the Landau damping arising from the spread of hot particle drift velocities. It is found that the "precessional layer" mode is destabilized near the pressure gradient value at which drift reversal is achieved. Its growth rate is proportional to N^{-4}, where N^{-2} is a coupling constant γ^2/sub MHD// omega-tilde^2/sub κ/ [omega-tilde/sub κ/ is the curvature frequency, γ/sub MHD/ is the typical magnetohydrodynamic (MHD) growth rate]. In addition the unstable interaction of the precessional layer mode with surface waves that can propagate below and above the ion-cyclotron frequency is described. Below the ion-cyclotron frequency the surface wave resembles the Alfven wave, while above the ion-cyclotron frequency the surface wave resembles a whistler wave.

26311 **Raman scattering in a nearly resonant density ripple.** Barr, H.C.; Chen, F.F. (Department of Electrical Engineering, University of California, Los Angeles, California 90024). *Physics of Fluids;* **30**: No. 4, 1180-1188(Apr 1987).

Stimulated Raman scattering of light waves by an underdense plasma is affected by the presence of a density ripple caused by a simultaneously occurring stimulated Brillouin instability. The problem is treated kinetically for the particularly interesting case where the ripple has nearly the same wavelength as the plasma wave. The ripple is found to reduce the growth rate of the usual Raman instability but allows other decay modes to occur. Numerical results for the frequencies, growth rates, and k spectra of these modes are obtained. A physical explanation is given for a baffling result of the calculation. The physical picture is also of interest to particle acceleration by plasma waves.

26312 **Tokamak plasma current disruption infrared control system.** Kugel, H.W.; Ulrickson, M. (to Dept. of Energy, Washington, DC). US Patent 4,650,632. 17 Mar 1987. Filed date 16 Apr 1984. vp.

This patent describes a device for magnetically confining a plasma driven by a plasma current and contained within a toroidal vacuum chamber, the device having an inner toroidal limiter on an inside wall of the vacuum chamber and an arrangement for the rapid prediction and control in real time of a major plasma disruption. The arrangement is described which includes: scanning means sensitive to infrared radiation emanating from within the vacuum chamber, the infrared radiation indicating the temperature along a vertical profile of the inner toroidal limiter. The scanning means is arranged to observe the infrared radiation and to produce in response thereto an electrical scanning output signal representative of a time scan of temperature along the vertical profile; detection means for analyzing the scanning output signal to detect a first peaked temperature excursion occurring along the profile of the inner toroidal limiter, and to produce a detection output signal in repsonse thereto, the detection output signal indicating a real time prediction of a subsequent major plasma disruption; and plasma current reduction means for reducing the plasma current driving the plasma, in response to the detection output signal and in anticipation of a subsequent major plasma disruption.

26313 **High-temperature plasmas in a tokamak fusion test reactor.** Strachan, J.D.; Bitter, M.; Ramsey, A.T.; Zarnstorff, M.C.; Arunasalam, V.; Bell, M.G.; Bretz, N.L.; Budny, R.; Bush, C.E.; Davis, S.L.; and others. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 08544). *Physical Review Letters;* **58**: No. 10, 1004-1007(9 Mar 1987).

Neutral-beam heating of plasmas in the Tokamak Fusion Test Reactor at low preinjection densities [n/sub e/(0)≃10/sup 19/ m/sup -3/] were characterized by T/sub e/(0) = 6.5 keV, T/sub i/(0) = 20 keV, n/sub e/(0) = 7 x 10/sup 19/ m/sup -3/, tau/sub E/ = 170 msec, β/sub t//sub h//sub e//sub t//sub a/ = 2, and a d(d,n)^{3}He neutron emission rate of 10/sup 16/ sec/sup -1/. The ion temperature and the deuterium-fusion neutron yields were significantly higher than for previous tokamak experiments. The low initial densities were achieved by operation of the Tokamak Fusion Test Reactor with low plasma currents (≦1 MA) and by extensive limiter conditioning.

26314 **Plasma performance of the central cell of a Cat-D tandem mirror reactor.** Mirin, A.A.; Shuy, G.W.; Dobrott, D. (National Magnetic Fusion Energy Computer Center, Lawrence Livermore National Lab., Livermore, CA 94550). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-15**: No. 1, 42-50(Feb 1987). Contract AC03-81ER53113.

A particle and power balance assessment of the central cell of a conceptual D-D tandem mirror reactor (TMR) is carried out using a two-dimensional (2-D) Fokker-Planck code and a zero-dimensional (0-D) simulation code. The two computational models produce excellent agreement except for the mean triton energy, the difference in which can be attributed to the fact that the 2-D code considers the long slowing-down time of the tritium. It is demonstrated that for an ion confining potential between 200 and 300 keV, a) the central cell of a catalyzed-deuterium (Cat-D) fueled TMR can achieve ignition in the temperature range of 40-60 keV, b) the alpha ash buildup must be strictly controlled to obtain an economical ratio of electrostatic confining potential to central-cell temperature phi/T, allowing the exhaust tritium to beta decay to helium-3 prior to reinjection results in roughly the same net electrical power output, and c) injecting extra tritium beyond that bred in the plasma allows a drop in the minimum ion confining potential required for ignition. It is shown that the ion confining potential is minimized when T/sub ic/ = 50 keV; this results in a plasma Q of 26. A quantitative comparison with a D-T reactor scenario is presented. It is shown that under ideal operating conditions, a conceptual Cat-D TMR has a 35-40 percent higher power conversion efficiency than a D-T device; this must be weighed against the higher temperature and plugging requirements of Cat-D.

26315 **Temporally resolved spectroscopy of laser-induced carbon ablation plasmas.** Brake, M.L.; Meachum, J.; Gilgenbach, R.M.; Thornhill, W. (Nuclear Engineering Dept., Univ. of Michigan, Ann Arbor, MI 48109). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-15**: No. 1, 73-77(Feb 1987).

Temporally resolved emission spectra (360-630 nm) of carbon ablation plasmas produced during laser hole boring by a 25-ns duration 1-J ruby laser pulse are presented. The emitted line radiation originates from C/sup +++/ to C/sup +/ depending upon the time relative to the laser pulse. Plasma temperatures of 12-14 eV during the laser pulse to about 4 eV, 140 ns after the laser pulse are obtained by comparing the spectroscopic results to a collisional-radiative equilibrium (CRE) model which bridges the gap between the local thermodynamic equilibrium (LTE) model and the coronal model.

26316 **Anomalous-viscosity current drive.** Stix, T.H.; Ono, M. (to Dept. of Energy). US Patent Application 6-855,568. 25 Apr 1986. 36p. Contract AC02-76CH03073. DE87007239 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007239.

The present invention relates to a method and apparatus for maintaining a steady-state current for magnetically confining the plasma in a toroidal magnetic confinement device using anomalous viscosity current drive. A second aspect of this invention relates to an apparatus and method for the start-up of a magnetically confined toroidal plasma.

26317 **Generation and use of spontaneous x-ray emission from laser-heated plasmas.** Nagel, D.J. (Naval Research Lab., Washington, DC 20375-5000). pp 142-150 of High intensity laser processes. Alcock, A.J. Bellingham, WA; SPIE Society of Photo-Optical Instrumentation Engineers (1986). (CONF-860620—).

From Society of Photo-Optical Instrumentation Engineers international symposium: topics in optical and optoelectronic applied sciences and engineering; Quebec City, Canada (2 Jun 1986).

Characteristics of gas (excimer) and solid (Nd:YAG) laser systems now available are summarized along with a discussion of near term prospects. The transport and focusing of laser pulses to attain irradiances necessary for x-ray generation are then surveyed. The laser-plasma is essentially a transducer for matter and energy, emitting material in addition to the photons of interest here. Recent progress and needed measurements of x-rays from laser-generated plasmas are summarized. Prospects for construction of beam lines to transport x-rays from the plasma to a sample, similar to the behavior of synchrotron x-radiation beam lines, are discussed briefly. Applications of x-rays from laser-plasmas are summarized, with emphasis on recent work.

26318 **Kinetic simulation of nonlinear kink instabilities.** Zaidman, E.G. Austin, TX; Univ. of Texas (1986). 121p. University Microfilms Order No. 87-00,314.

Thesis (Ph. D.).

A particle simulation study of kink and twist-kink instabilities in magnetized plasmas is presented. Plasma particle simulation codes self-consistently follow the time evolution of the individual and collective aspects of particle dynamics as well as wave dynamics in a fully nonlinear fashion. The twist-kink mode is a possible mechanism for fast release of magnetic energy into thermal or mechanical in modeling the physics of solar flares, tandem mirrors, and other laboratory devices. A particle simulation model was developed for these applications that incorporates Darwin's formulation of the electromagnetic fields with a guiding center approximation for electron motion perpendicular to the ambient magnetic field with the inclusion of all three dimensions. This enables exploration of magnetoactive kinetic plasma physical processes at low frequencies without restrictions of lower dimensionality, which have heretofore not been available. Implementation of this model and the examination of its theoretical and computational properties are presented. Using this model, the author examined several cases of kink and twist-kink instabilities in a three-dimensional slab as candidates for a fast energy release mechanism in a plasma, three dimensional extensions of two-dimensional process such as the coalescence instability.

26319 **Stability of ballooning modes in tokamaks with energetic particles.** Dominguez, V.N. Austin, TX; Univ. of Texas (1986). 245p. University Microfilms Order No. 87-00,183.

Thesis (Ph. D.).

The effects of energetic particles are of interest since fast ions are present in neutral beam and rf-heated tokamaks and will occur in ignition devices in the form of alpha particles. Moreover, it may be desirable to create such particles by auxiliary heating in order to exploit their stabilizing properties and thus attain a high beta plasma. Here a range of issues related to the stabilization of MHD ballooning modes in tokamaks by using energetic particles is investigated analytically and numerically. The presence of a highly energetic plasma component can stabilize MHD ballooning modes in tokamaks and may allow direct access to the high-beta second stability regime. Here, an improved estimate of such stability was obtained, in the large-aspect-ratio circular limit, by means of a variational refinement of the lower bound for the energetic-particle potential energy. The effect of various profiles for the hot-particle pressure on stability is investigated and the stability of off-angle modes is explored. Moderately energetic particles, however, can destabilize the plasma through resonant interaction at their curvature drift frequency. Finally, even if the ideal modes and resonantly excited modes can be simultaneously stabilized, resistive ballooning instabilities may persist.

26320 **Effect of energetic particles on stability of mirror and tokamak plasmas.** Stotler, D.P. Austin, TX; Univ. of Texas (1986). 236p. University Microfilms Order No. 87-00,288.

Thesis (Ph. D.).

Effects of an energetic particle species on high-mode-number, curvature-driven instabilities in magnetic mirror and tokamak plasmas are studied. The author investigates whether or not these hot particles can stabilize the magnetohydrodynamic (MHD) ballooning mode by having magnetic drift velocities large enough that they do not respond on the usual time scale of the instability and consequently allow thermonuclear fusion devices to operate at higher, more efficient plasma pressures. However, the energetic particles themselves are subject to instabilities that limit the effectiveness of this procedure. Using an MHD particle simulation code, the stabilizing effect of a diamagnetic well formed by the energetic particles is demonstrated in an axisymmetric mirror by treating the hot species as a rigid current ring. The results match those predicted by an analytic theory based on the MHD equations. More general aspects of linear stability in mirrors containing energetic particles are examined through analysis of equations derived from the drift kinetic equation. Numerical techniques are used to show that a magnetic compressional instability can arise if the core plasma density is to high or if the hot particle pressure gradient is too large. A similar set of equations is solved numerically in a tokamak geometry to determine whether or not energetic particles will allow access to the desirable second stability region for MHD ballooning modes.

26321 **Diagnostics of high temperature deuterium and tritium plasmas by spectrometry of radiative capture reactions.** Cecil, F.E.; Newman, D.E. (Colorado School of Mines, Golden). *Nuclear Instruments and Methods in Physics Research;* **221**: 449-452(1984). Contract AC02-83ER40091.

The high resolution gamma ray spectrometry of the ground state radiative capture reactions $d(p,\gamma)^3He$, $t(p,\gamma)^4He$, $d(t,\gamma)^5He$ and $d(d,\gamma)^4He$ is proposed as a temperature diagnostic of energetic hydrogen plasmas. Counting rates for these reactions for temperatures and densities characteristic of current CTR research are estimated. 11 references, 2 figures, 1 table.

7002 Fusion Power Plant Technology

REFER ALSO TO CITATION(S) 24793, 24809, 24810, 25224, 25266, 25267, 25268, 25453, 25454, 25455, 25457, 25646, 25693, 26059, 26060, 26283, 26304, 26308

26322 **(ANL/FPP/TM—209) Size limitations for microwave cavity to simulate heating of blanket material in fusion reactor.** Wolf, D. (Argonne National Lab., IL (USA)). Jan 1987. Contract W-31109-ENG-38. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008076.

The power profile in the blanket material of a nuclear fusion reactor can be simulated by using microwaves at 200 MHz. Using these microwaves, ceramic breeder materials can be thermally tested to determine their acceptability as blanket materials without entering a nuclear fusion environment. A resonating cavity design is employed which can achieve uniform cross sectional heating in the plane transverse to the neutron flux. As the sample size increases in height and width, higher order modes, above the dominant mode, are propagated and destroy the approximation to the heating produced in a fusion reactor. The limits at which these modes develop are determined in the paper.

26323 **(ANL/FPP/TM—210) Proceedings of the regional electromagnetic workshop at Argonne National Laboratory.** Turner, L.R. (ed.). (Argonne National Lab., IL (USA)). Dec 1986. Contract W-31109-ENG-38. 99p. (CONF-8606260—Summ.). NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87004633.

From 2. regional electromagnetic workshop; Argonne, IL, USA (23 Jun 1986).

Separate abstracts were entered into the data base for each of the 7 included papers. (MOW)

26324 **(ANL/FPP/TM—211) 3-D transient eddy current calculations for the FELIX cylinder experiments.** Davey, K.R.; Turner, L.R. (Argonne National Lab., IL (USA)). Dec 1986. Contract W-31109-ENG-38. 43p. NTIS, PC A03/MF A01. File Number DE87007716.

The three-dimensional eddy current transient field problem is formulated first using the U-V method. This method breaks the vector Helmholtz equation into two scalar Helmholtz equations. Null field integral equations and the appropriate boundary conditions are used to set up an identification matrix which is independent of null field point locations. Embedded in the identification matrix are the unknown eigenvalues of the problem representing its impulse response in time. These eigenvalues are found by equating the determinant of the identification matrix to zero. When this initial forcing function is Fourier decomposed into its spatial harmonics, each Fourier component can be associated with a unique eigenvalue by this technique. The true transient solution comes through a convolution of the impulse response so obtained with the particular external field decay governing the problem at hand. The technique is applied to the FELIX cylinder experiments; computed results are compared to data. A pseudoanalytic confirmation of the eigenvalues so obtained is formulated to validate the procedure.

26325 **(CONF-870275—1-Vugraphs) ETR/INTOR (viewgraphs).** Flanagan, C.A. (Oak Ridge National Lab., TN (USA)). 1987. Contract AC05-84OR21400. 25p. NTIS, PC A02. File Number DE87007670.

From ETR/INTOR meeting; Livermore, CA, USA (12 Feb 1987).

Design drivers and design constraints are listed for the engineering design of FER. (MOW)

26326 **(CONF-8609266—1-Vugraphs) Remote maintenance for the compact ignition tokamak.** Spampinato, P.T. (Oak Ridge National Lab., TN (USA)). Sep 1986. Contract AC05-84OR21400. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005510.

From Japan Atomic Energy Research Institute conference; Naka, Japan (29 Sep 1986).

Viewgraphs are presented that cover the following areas: (1) maintenance features of the CIT; (2) in-vessel maintenance requirements and equipment; (3) ex-vessel maintenance requirements and equipment; (4) R and D activities for CIT maintenance; and (5) areas of common interest and possible collaboration. (MOW)

26327 **(DOE/DP/40197—1) Double-diffraction x-ray imaging camera: Final report.** (Rochester Univ., NY (USA). Lab. for Laser Energetics). [7 Apr 1987]. Contract AS08-84DP40197. 12p. NTIS MF A01; 2; GPO Dep. File Number DE87007936.

A device designed for obtaining monochromatic images of laser-plasma x-ray sources via the double diffraction process has been constructed. Such imaging, which is monochromatic and of high resolution, could for the first time make possible a study of the hydrodynamic stability of laser-target implosions. As a first step in the realization of such a possibility, a camera had to be designed and fabricated, for the precise alignment of doubly-diffracting crystals in the OMEGA tank. The design constraints were: the instrument has to be positioned as close to the target as possible (which will maximize the imaging resolution), while avoiding damage from the target explosion as well as avoiding interference with neighboring laser beams and other measuring devices in the OMEGA tank. This called for a "miniaturized" x-ray camera. To enable multi-shot operation without the need to extract the instrument from the vacuum tank between successive shots, a motorized, remotely-controlled operation was called for. In the following we briefly describe the finished instrument and its testing. We enclose photographs ad drawing pertaining to the imaging camera.

26328 **(DOE/DP/40200—37) University of Rochester, Laboratory for Laser Energetics: Annual report, 1 October 1985-30 September 1986.** (Rochester Univ., NY (USA). Lab. for Laser Energetics). Jan 1987. Contract FC08-85DP40200. 224p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE87005920.

In FY86 the Laboratory has produced a list of accomplishments in which it takes pride. LLE has met every laser-fusion program milestone to date in a program of research for direct-drive ultraviolet laser fusion originally formulated in 1981. LLE scientists authored or co-authored 135 scientific papers during 1985-86. The collaborative experiments with NRL, LANL, and LLNL have led to a number of important ICF results. The cryogenic target system developed by KMS Fusion for LLE will be used in future high-density experiments on OMEGA to demonstrate the compression of thermonuclear fuel to 100 to 200 times that of solid (20 to 40 g/cm^3) in a test of the direct-drive concept, as noted in the National Academy of Sciences' report. The excellence of the advanced technology efforts at LLE is illustrated by the establishment of the Ultrafast Science Center by the Department of Defense through the Air Force Office of Scientific Research. Research in the Center will concentrate on bridging the gap between high-speed electronics and ultrafast optics by providing education, research, and development in areas critical to future communications and high-speed computer systems. The Laboratory for Laser Energetics continues its pioneering work on the interaction of intense radiation with matter. This includes inertial-fusion and advanced optical and optical electronics research; training people in the technology and applications of high-power, short-pulse lasers; and interacting with the scientific community, business, industry, and government to promote the growth of laser technology.

26329 **(DOE/ER/52123—1) Modeling, analysis and experiments for fusion nuclear technology: FNT progress report: Modeling and FINESSE.** Abdou, M.A.; Tillack, M.S.; Raffray, A.R.; Hadid, A.H.; Bartlit, J.R.; Bell, C.E.C.; Gierszewski, P.J.; Gordon, J.D.; Iizuka, T.; Kim, C.N. (California Univ., Los Angeles (USA). Dept. of Mechanical, Aerospace and Nuclear Engineering). Jan 1987. Contract FG03-86ER52123. 561p. (PPG—1021; UCLA-ENG—86-44). NTIS, PC A24/MF A01; 1; GPO Dep. File Number DE87007965.

This document is a progress report on two technical studies carried out during 1986, both of which relate to the implementation phase of FNT. The first, which is a follow-up to FINESSE, focuses on specific key questions for: (1) very near-term (0 to 3 years) non-fusion experiments and facilities, and (2) FNT testing in a fusion facility. The second is the initial stage of a detailed effort to develop theory, models and computer codes for predicting the performance of nuclear components. Chapters are presented on (1) introduction and chapter summaries, (2) non-fusion experiments and facilities, (3) fusion testing issues, and (4) theory and modeling. Chapter 2 is an assessment of the relative advantages of many solid breeders, neutron multipliers and configurations. Various issues affecting design and cost of the blanket are examined in Chapter 3. Chapter 4 reports on the progress of the initial stage of an effort to develop theory and analytical and numerical models for nuclear components. A major part of the effort has focused on modeling of MHD effects for liquid metal blankets. Progress has also been made on modeling tritium transport and inventory in solid breeder blankets and the thermomechanical behavior of liquid-metal-cooled limiters. (MOW)

26330 (DOE/NV/10511—1) Radiation damage to coatings for short wave length laser mirrors: Final report for the period September 25, 1985 to September 24, 1986. Pertzborn, D.; Kulcinski, G.L. (Wisconsin Univ., Madison (USA). Fusion Technology Inst.). Nov 1986. Contract AS08-85NV10511. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87001696.

Several specimens of highly reflecting (HR) and anti-reflecting (AR) mirrors have been irradiated at the University of Wisconsin in 1985-86. It is shown that at damage levels of 10^{11} rads and higher, visible optical absorption changes take place. By 10^{12} rads (0.05 dpa in the coating and 0.7 dpa in the substrate), the damage is so severe that the mirror is probably unusable.

26331 (EGG—2481) Fusion Safety Program annual report, fiscal year 1985. Holland, D.F.; Merrill, B.J.; Herring, J.S.; Piet, S.J.; Longhurst, G.R. (EG and G Idaho, Inc., Idaho Falls (USA)). Feb 1987. Contract AC07-76ID01570. 110p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87006196.

The Fusion Safety Program (FSP) has supported magnetic fusion technology for seven years, and this is the seventh annual report issued by the FSP. Program focus is identification of the magnitude and distribution of radioactive inventories in fusion reactors, and research and analysis of postulated accident scenarios that could cause the release of a portion of these inventories. Research results are used to develop improved designs that can reduce the probability and magnitude of such releases and thus improve the overall safety of fusion reactors. During FY-1985, research activities continued and participation continued on the Ignition Systems Project (ISP). This report presents the significant results of EG&G Idaho, Inc., activities and those from outside contracts, and includes a list of publications produced during the year, and activities planned for FY-1986.

26332 (LA—10908-MS) The spheromak as a compact fusion reactor. Hagenson, R.L.; Krakowski, R.A. (Los Alamos National Lab., NM (USA)). Mar 1987. Contract W-7405-ENG-36. 119p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE87007724.

After summarizing the economic and utility-based rationale for compact, higher-power-density fusion reactors, the gun-sustained spheromak concept is explored as one of a number of poloidal-field-dominated confinement configurations that might improve the prospects for economically attractive and operationally simplified fusion power plants. Using a comprehensive physics/engineering/costing model for the spheromak, guided by realistic engineering constraints and physics extrapolation, a range of cost-optimized reactor design points is presented, and the sensitivity of cost to key physics, engineering, and operational variables is reported. The results presented herein provide the basis for conceptual engineering designs of key fusion-power-core (FPC) subsystems and more detailed plasma modeling of this promising, high mass-power-density concept, which stresses single-piece FPC maintenance, steady-state current drive through electrostatic magnetic helicity injection, a simplified co-axial electrode-divertor, and efficient resistive-coal equilibrium-field coils. The optimal FPC size and the cost estimates project a system that competes aggressively with the best offered by alternative energy sources while simplifying considerably the complexity that has generally been associated with most approaches to magnetic fusion energy.

26333 (LA-UR—86-3972) Oscillating virtual cathode, large-orbit gyrotron and driver. VanHaaften, F.W.; Hoeberling, R.F.; Fazio, M.V. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 5p. (CONF-861240—17). NTIS, PC A02. File Number DE87003713.

From 3. national conference on high power microwave technology for defense applications; Albuquerque, NM, USA (1 Dec 1986).

Studies using an oscillating virtual cathode (vircator) and a large-orbit gyrotron to generate microwave levels of several hundred megawatts are being conducted at the Los Alamos National Laboratory (LANL). A pulse level of ~1 MV, with length approaching 1 μs at a repetition rate of a few hertz, is anticipated for extension of these studies from the present single-shot mode with 100-ns pulse width. The increased pulse width is needed to test longer pulse length microwave sources. Pulse forming network (PFN), transformer-coupled drivers have been studied and are part of the subject of this paper. The large-orbit gyrotron is discussed here.

26334 (LBL—21345-Rev.) Experiments and prospects for induction linac drivers. Keefe, D. (Lawrence Berkeley Lab., CA (USA)). Dec 1986. Contract AC03-76SF00098. 14p. (CONF-860510—17-Rev.). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006144.

From Symposium on heavy ion inertial fusion; Washington, DC, USA (27 May 1986).

In the last three years, the US program in Heavy Ion Fusion has concentrated on understanding the induction linac approach to a power-plant driver. In this method it is important that the beam current be maximized throughout the accelerator. Consequently, it is crucial to understand the space-charge limit in the AG transport system in the linac and, also, to achieve current amplification during acceleration to keep pace with the kinematical increase of this limit with energy. Experimental results on both these matters and also on the use of multiple beams (inside the same accelerating structure) will be described. A new examination of the most attractive properties of the induction linac for a fusion driver has clearly pointed to the advantage of using heavy ions with a charge-state greater than unity - perhaps $q = 3$ may be an optimum. This development places even greater importance on understanding space-charge limits and mechanisms for emittance growth; also, it will require a new emphasis on the development of a suitable ion source.

26335 (ORNL—6234, pp 1.3-1.57) **Toroidal confinement experiments.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

The Advanced Toroidal Facility (ATF) torsatron was the major focus of work in the area of toroidal confinement experiments during 1985. Studies have documented more clearly the flexibility that ATF will provide in investigating a range of magnetic configurations and have elucidated features that relate to control of plasma density and impurities. The construction project progressed well, with completion set for late 1986. The experimental program was more clearly defined, and extensive preparations were well under way at year's end. These efforts are described. In the area of advanced projects activities were carried out on two fronts. Stellarator reactor studies focused on ATF-like configurations that retain the potential for high beta at even lower aspect ratios, and the spherical torus concept was developed to the proposal stage and favorably reviewed by the Office of Fusion Energy. Confinement studies were carried out to establish physics requirements and options for compact ignition tokamak (CIT) experiments, as an aid for design selection and optimization. Details of these and other advanced studies are given. Active collaborations continued in several areas.

26336 (ORNL—6234, pp 4.1-4.13) **Plasma-materials interactions.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

Over the past year, plasma edge diagnostics for the Advanced Toroidal Facility were identified, and the design of hardware was initiated. These diagnostics are being prepared to study plasma density and temperature, particle and heat fluxes, impurity production and transport, and the configuration of the edge plasma. The conceptual design of top and bottom rail limiters, configured as calorimeter arrays, was finished, and detailed engineering design is under way. In collaboration with Japan and the Federal Republic of Germany, the PMI group is responsible for H/sub α/ measurements and the helium removal experiment on the ALT-II experiment in TEXTOR. Initial H/sub α/ measurements and calibration of the detectors were performed on TEXTOR. Several concepts have been investigated and the associated diagnostics identified to implement a helium removal experiment on ALT-II. In collaboration with France, a pump limiter system for steady-state operation is being designed for Tore Supra. In the past year, several concepts for pump limiter systems were studied, and predictive modeling of heat and particle removal was performed. Studies of plasma-surface phenomena were concentrated during the past year on graphites, wall carbonization, erosion/redeposition, and postmortem analysis of limiters. Erosion/redeposition experiments were performed with the ^{13}C technique in collaboration with the JET and TEXTOR groups. Other initiatives include studies of surface effects on the performance of rf components.

26337 (ORNL—6234, pp 5.1-5.41) **Plasma technology.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

Several new pellet injector concepts were initiated. A simplified injector was built as a prototype of a tritium injector with a minimal tritium inventory and no moving parts in the cryostat. A scale-up of the centrifuge pellet injector can accelerate multiple large pellets for extended pulse lengths; this device uses a punch to generate pellets of controlled variable size. The ORNL repeating pneumatic injector was used to inject single large (4-mm-diam) or multiple smaller (2.7-mm-diam) pellets into the Tokamak Fusion Test Reactor. Injection of single pellets results in a high density on the axis (n/sub e/ = 1.8 x 10^{14} cm^{-3}). At lower density the pellets result in significantly longer energy confinement times in the plasma center. Future applications of rf heating in plasma devices will require higher power at higher frequencies with improved coupling efficiency from the source to the plasma. These needs are being met through collaboration with other laboratories and with industry in developing higher power sources, components, and antennas. Construction of the RF Test Facility was completed, and initial plasma operation began in 1985. This device uses superconducting magnet coils from the ELMO Bumpy Torus Proof-of-Principle project and has created a plasma using 10.6 GHz power for electron cyclotron heating. Microwave sintering of ceramic materials will be investigated using a test facility constructed in 1985. The microwave source for these experiments will be a 28-GHz gyrotron oscillator, which can provide up to 200 kW.

26338 (ORNL—6234, pp 6.1-6.10) **Superconducting magnet development.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

A major milestone in the international Large Coil Task (LCT) was reached in October 1985, when experimental operation of a six-coil toroidal array of superconducting test magnets was begun. During the first months of the year, work in the International Fusion Superconducting Magnet Test Facility (IFSMTF) consisted of installing the five completed test coils and the system of remotely movable pulse coils. Meanwhile, Westinghouse encountered a technical problem with one component of its coil, which delayed delivery until August. This placed extreme schedule pressure on its installation in the IFSMTF. Foreign participants in the LCT expressed grave concern to the Department of Energy, which was allayed only when extraordinary effort by the ORNL Fusion Energy Division, the Engineering Division of Martin Marietta Energy Systems, Inc., and the Y-12 Maintenance Division resulted in installation of the Westinghouse coil and remaining equipment and closing of the vacuum tank by the date that had been promised before the setback at Westinghouse occurred. Following the closure of the 11-m-diam tank housing the test array, a satisfactory vacuum was achieved, and cooldown to the required cryogenic operating temperature was started in December. There were some delays due to problems with the helium compressor system, and the cooldown was interrupted for replacement of a leaking helium heat exchanger. On the whole, however, at the end of the year, prospects were good for achievement of all the goals of the LCT test program within a reasonable period of time. Concurrently with the mainline effort on the LCT, development of advanced superconductor concepts continued at a modest level.

26339 (ORNL—6234, pp 7.1-7.32) **Fusion engineering design center.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

In the spring of 1985, the Department of Energy (DOE) directed the Design Center to take a lead responsibility in assessing the engineering feasibility of a very compact tokamak experiment with copper coils. Following this assessment, the Design Center studied the Ignitor concept at the request of DOE and arrived at a design configuration. Many features of this configuration have been incorporated into the national baseline conceptual design for a Compact Ignition Tokamak (CIT). The Design Center continued to participate in the mirror program by contributing to the Minimars design effort, a two-year program to develop and describe an attractive tandem mirror reactor concept. The Design Center's principal role is in configuration definition of the candidate concepts. The Design Center continues to lead the engineering activities for the International Tokamak Reactor program. Advanced commercial tokamaks were studied by the Design Center as part of the Tokamak Power Systems Studies project coordinated by the DOE Office of Fusion Energy. The Design Center also provided design integration of the US effort. A cost accounting system that is applicable to all magnetic fusion reactor design studies was developed and applied to different confinement concepts and types of projects. The system provides the structure for development of a fusion cost database and validated cost estimating procedures.

26340 (ORNL—6234, pp 8.1-8.18) **Materials research and development.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

The Alloy Development for Irradiation Performance (ADIP) and Damage Analysis and Fundamental Studies (DAFS) programs are concerned primarily with fusion reactor structural materials. Efforts to develop austenitic stainless steels are carried out in collaboration with Japan under the agreement for US-Japan Collaborative Testing of First Wall and Blanket Structural Materials. Spectral tailoring irradiation experiments in the Oak Ridge Research Reactor and the High-Flux Isotope Reactor are being used to explore irradiation response at He/dpa levels of the fusion spectrum and at temperatures (60-400°C) and damage levels (up to 50 dpa) appropriate to near-term reactors such as the Fusion Engineering Reactor. Other experiments explore higher damage levels to determine the maximum useful life of such alloys and to provide understanding on which further development can be based. Radiation effects in vanadium alloys are being explored employing the elevated-temperature tritium trick to introduce fusion-relevant helium levels and subsequent irradiation in the FFTF to create displacement damage. In ferritic steels the response of their reference alloys HT-9 and 9 Cr-1 Mo to neutron damage, with particular emphasis on impact and tensile properties is emphasized. In corrosion studies emphasis has shifted to low-activation alloys, with continuing research on standard alloys to aid development of corrosion-resistant materials and possible inhibitive techniques for liquid-metal environments. The program on insulators and stabilizers for superconducting magnets (the Special Purpose Materials Program) has focused on providing facilities at the National Low-Temperature Neutron Irradiation Facility for research in the area of radiation effects on magnet materials. This facility will provide temperatures and irradiation conditions similar to those at the magnets of a fusion reactor.

26341 (ORNL—6234, pp 9.1-9.7) **Neutron transport.** Jul 1986. NTIS, PC A16/MF A01. File Number DE86015983.

In Fusion Energy Division annual progress report, period ending December 31, 1985.

The neutron transport program includes both experimental and analytic phases. The experimental program is designed to provide the data necessary for verifying the analytic method and cross-section data used for fusion reactor neutronics design calculations. Experiments are carried out to determine neutron and photon transport in typical fusion reactor shield materials and configurations and to determine the effects of penetrations in these shields. The analytic program supports the design of the integral experiments and compares calculated data with data obtained experimentally. During the past year, neutronics experiments were conducted at ORNL and, in collaboration with the staff at Princeton Plasma Physics Laboratory, on the Tokamak Fusion Test Reactor. Work was also performed in the area of nuclear data evaluation and cross-section processing, and the Radiation Shielding Information Center continued to supply a broad range of services to the fusion energy research community.

26342 **(ORNL/TM—10310) Hydrogen recycle and isotope exchange from dense carbon films.** Clausing, R.E.; Heatherly, L. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 19p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007835.

Dense carbon films were prepared by deposition from hydrogen plasmas to which methane was added. The initial hydrogen recycle coefficient from the films ranges from more than two to less than one. The films contain large amounts of hydrogen (up to 50 at. %). They adjust themselves to provide recycling coefficients near unity. Isotope changeover times tend to be long. The reservoir of hydrogen instantly available to the plasma to maintain or stabilize the recycle coefficient and isotopic composition of the plasma is 10^{15} cm^{-2} or greater depending on film preparation, temperature, and prior plasma exposure conditions. Simulator observations tend to support and improve the understanding of the observations in TEXTOR and JET; however, they also point out the need for control of film deposition and operating parameters to provide desirable and reproducible properties. The films and the hydrogen isotopes they contain can be removed easily by plasma processes. Since the hydrogen in these films is relatively immobile except in the zone reached by energetic particles, or at temperatures above 400°C, dense carbon films may be useful in managing the tritium recovery from near-term fusion experiments.

26343 **(PPPL—2409) A rotating arc plasma invertor.** Reusch, M.F.; Jayaram, K. (Princeton Univ., NJ (USA). Plasma Physics Lab.; Colorado State Univ., Fort Collins (USA). Dept. of Electrical Engineering). Feb 1987. Contract AC02-76CH03073. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008066.

A device is described for the inversion of direct current to alternating current. The main feature is the use of a rotating plasma arc in crossed electric and magnetic fields as a switch. This device may provide an economic alternative to other inversion methods in some circumstances.

26344 **(PPPL—2417) TFTR plasma regimes.** Hawryluk, R.J.; Arunasalam, V.; Bell, M.G.; Bitter, M. Blanchard, W.R.; Bretz, N.L.; Budny, R.; Bush, C.E.; Callen, J.D. Cohen, S.A. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Feb 1987. Contract AC02-76CH03073. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87008069.

Significant extensions in the TFTR plasma operating regimes have been achieved with additional heating-system capability, installation of a multishot pellet injector, and the development of an enhanced confinement regime. In ohmically heated pellet-fueled discharges characterized by highly peaked density profiles, enhancements in tau/sub E/ have resulted in n/sub e/(0)tau/sub E/ (a)-values of 1.5 x 10^{20} m^{-3}s. In neutral-beam-heated discharges, an operating regime has been developed in which substantial improvements in energy confinement time and neutron source strength are observed. Ion temperatures of ~20 keV and n/sub e/(0)tau/sub E/ (a)T/sub i/(0)-values of 2 x 10^{20} m^{-3}s keV have been achieved. This enhanced confinement regime is characterized by high values of β/sub p/ and low values of collisionality. The observed surface voltage, which is negative during beam injection, is compared with models including beam-driven and bootstrap currents.

26345 **(SAND—86-2444C) Design and performance of a moveable-post cathode magnetron sputtering system for making PBFA [Particle Beam Fusion Accelerator] II accelerator ion sources.** Mattox, D.M.; Cuthrell, R.E.; Peeples, C.R.; Dreike, P.L. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 19p. (CONF-870388—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007773.

From International conference on metallurgical coatings; San Diego, CA, USA (23 Mar 1987).

A post cathode magnetron sputter deposition system is described for depositing one-two-or three layer coatings with uniform thickness and film properties on the inside of a cylindrical substrate. The system utilizes a unique moveable post cathode which allows the substrate to remain stationary during the deposition process. Film stress is controlled by cycling the sputtering pressure during the sputter deposition process.

26346 **(UCID—20998) Evaluation of the TIBER Engineering Test Reactor under pulsed inductive operation: Supplement to the TIBER II 1986 status report.** Perkins, L.J.; Logan, B.G.; Henning, C.D.; Miller, J.R.; Bulmer, R.H.; Fenstermacher, M.E.; Schultz, J.H.; Porkolab, M.; Bonoli, P.; Doggett, J.N. (Lawrence Livermore National Lab., CA (USA)). 9 Feb 1987. Contract W-7405-ENG-48. 41p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007520.

TIBER is being pursued as the US option for the prospective Engineering Test Reactor (ETR). The baseline TIBER design is a 3 m major radius, steady-state machine with non-inductive current-drive. Full details of the present design including the physics and technology assumptions for current-driven operation are given in the 1986 status report. In this paper, we will investigate, as a contingency, pulsed inductive operation of TIBER employing whatever limited volt-seconds capability is available from the machine configuration for the steady-state design. Our purpose is to demonstrate that TIBER could be chosen as a basis for the ETR design by the expected design qualification date (early 1990s), before we have sufficient time to fully qualify all aspects of steady-state current drive with sufficient reduction of uncertainty. Therefore, besides being capable of full non-inductive, current-driven, steady-state operation, the following pulsed mode of operation will be investigated for the same 3 m major radius machine (i.e., same magnet set and reactor configuration).

26347 **(UCRL—15900) Role of cavitons in laser-plasma interactions: Final report for the period August 15, 1984-August 14, 1985.** Wong, A.Y.; Tanikawa, T. (California Univ., Los Angeles (USA). Dept. of Physics; Lawrence Livermore National Lab., CA (USA)). Sep 1986. Contract W-7405-ENG-48. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87008485.

We have observed three new phenomena associated with cavitons generated at the critical layer in an inhomogeneous plasma. Half-harmonic [(1/2)ω_0, (3/2)ω_0, etc.] electromagnetic (em) radiation, accompanying the resonant absorption of the high-power microwave at ω_0 by an inhomogeneous plasma, appears to originate from the cavitons. Double layers have been found to develop near the locations of cavitons. Acceleration of ions by these double layers has also been observed. The evolution of resonantly excited electron plasma waves and density profile modification at the critical layer has been studied in detail. Conditions under which the role of cavitons becomes significant in em wave-plasma interactions are discussed.

26348 **Injection, containment and heating device for fusion plasmas.** Knorr, G.E. (to University of Iowa Research Foundation, Iowa City, IA). US Patent 4,650,631. 17 Mar 1987. Filed date 14 May 1984. vp.

An apparatus is described for containing and accelerating a beam of charged particles comprising: a torus-shaped vacuum container means; a plurality of magnetic means, each of the magnetic means encircling the torus in a plane so as to form a magnetic field in the shape of circular line cusps; at least one charged particle injection means for generating and injecting charged particles into the container means; a magnetic junction joining each of at least one charged particle injection means and the container means the magnetic junction having a tapered shape with the upstream end having a width approximately equal to the sum of the widths of the container means and the injector means and with the downstream end being the same shape as the container means; some of the plurality of magnetic means encircling the magnetic junction with the magnetic means being racetrack shaped at the upstream end and decreasing in width near the downstream end; wherein the charged beam is contained and accelerated in the container means by the magnetic means and the charged particle injection means injects additional charged particles into the beam of charged particles through the magnetic junction.

26349 **(UCRL-Trans—12173) The laser "key" to thermonuclear energy.** Gus'kov, S.Yu.; Rozanov, V.B. Translated from *Physics ;* No. 4, 1-65(Mar 1987). Contract W-7405-ENG-48. 84p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87006830.

This booklet treats a promising direction of accomplishing control of thermonuclear reactions - laser thermonuclear synthesis. It presents the physics of the interaction of laser radiation with matter and the heating, compression and confinement of laser plasma. Basic achievements of theoretical and experimental research into LTS are discussed. The outlook for LTS in physics and power engineering is analyzed.

26350 **Openings in a fusion reactor blanket (tokamak type): Trends in nuclear characteristics.** Brzosko, J.S.; Robouch, B.V.; Ingrosso, L. (Stevens Institute of Technology, Hoboken, NJ). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-15**: No. 1, 16-27(Feb 1987).

This paper briefly reports on the effects of openings (heating and pumping ducts) in a breeding blanket of a fusion reactor with tokamak physics on its nuclear characteristics. Predictions are based on 3-D Monte Carlo computations using the 3DAMC-VINIA subroutine complex operating without any numerical or geometrical simplifications; the ENDF/B library data are used in extenso. An analysis of the numerical results reveals a strong depression of tritium breeding, energy production, and an increase in neutron leakage. Analytical formulas proposed here fit all the numerical results well and permit, on the basis of numerical data for unported blankets (no openings), the prediction of the depression effects as a function of the magnitude and number of openings. The role of the position, shape, and/or number of openings is also shown.

26351 **Cryopumping for fusion reactors.** Sedgley, D.W.; Tobin, A.G.; Batzer, T.H.; Call, W.R. (Grumman Aerospace Corp., Bethpage, NY, USA; Lawrence Livermore National Lab., CA, USA). *Nuclear Engineering and Design/ Fusion;* **4**: No. 2, 149-163(Jan 1987).

Fusion reactors will exhaust large volumes of hydrogen species and helium, and cryopumps can satisfy the pumping needs. Two programs described here were undertaken to develop the high performance, continuous operation required. The capability of charcoal as a cryogenic sorbent was optimized and improved by use of specific charcoal types and grades, and by use of thermally conductive bonds for attaching the charcoal to the cryogenically cooled substrate. A 30% demonstrated pumping speed improvement is significant for a system in which the pump dimensions are measured in tens of square meters. An automatically controlled continuous duty cryopump system was developed, fabricated and demonstrated. The system pumps deuterium, and can be readily modified to pump helium by addition of a sorbent such as charcoal. This two-unit system has one unit being regenerated while the other unit is pumping. It is prototypical of a fusion reactor pump in which five units would be pumping for each unit that is being regenerated. Low tritium holdup is projected for an operational installation.

26352 **Coated ceramic breeder materials.** Tam, S.W.; Johnson, C.E. (to Dept. of Energy). US Patent Application 6-899,139. 22 Aug 1986. 13p. Contract W-31109-ENG-38. DE87007212 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007212.

A lithium containing ceramic breeder material is described which is coated with a neutron multiplier such as Beryllium (Be), Beryllium Oxide (BeO), or other material having a higher thermal conductivity than the lithium ceramic material itself. In addition to exhibiting certain thermal conductivity properties, the neutron multiplier must be capable of withstanding the high temperatures (700° to 1300°K) experienced in a breeder blanket of a fusion reactor. State of the art considerations have indicated several possible configurations for the lithium containing ceramic breeders, including a sphere-pac arrangement or sintered pellets or blocks. When one adds a neutron multiplier such as Be or BeO into a sphere-pac bed of lithium containing ceramic breeders, current concepts include mixing the neutron multiplier randomly into the sphere-pac bed in the form of small spheres of a size comparable to that of the lithium ceramic particles. The present invention shows that a sphere-pac bed of breeder particles coated with a neutron multiplier such as Be and BeO has an improved thermal conductivity when compared with that of a bed of uncoated breeder particles randomly mixed with Be or BeO spheres having the same breeder/multiplier composition ratio.

26353 **Electrohydrodynamically driven large-area liquid ion sources.** Pregenzer, A.L. (to Dept. of Energy). US Patent Application 6-867,175. 27 May 1986. 27p. Contract AC04-76DP00789. DE87007259 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007259.

It is an object of this invention to provide a large area, two dimensional, liquid source of ions (e.g., cations such as metal ions), as well as a method of achieving large area liquid ion currents. It is a further object of this invention to provide such a source which satisfies the stringent conditions for a light ion-beam driver for inertial confinement fusion.

26354 **Compact waveguide power divider with multiple isolated outputs.** Moeller, C.P. (to Dept. of Energy). US Patent Application 6-867,128. 27 May 1986. 23p. Contract AC02-76CH03073. DE87007258 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007258.

The waveguide power divider comprises an input waveguide of rectangular cross-section coupled to multiple reduced height output waveguides of rectangular cross-section. The input is coupled to the output waveguides by axial slots. The length of the slots is selected such that the wave direction of the input waveguide is preserved in the output waveguides. The width of the output guide is equal to the width of the input waveguide so that the input and output guides have the same cutoff wavelength. Waves will then travel with the same phase velocity in the input and output guides. The unused ends of the input and output guides are terminated in matched loads. The load at the end of the input guide absorbs power that is not coupled to the output guides.

26355 **Spheromak reactor with poloidal flux-amplifying transformer.** Furth, H.P.; Janos, A.C.; Uyama, T.; Yamada, M. (to Dept. of Energy). US Patent Application 6-866,031. 21 May 1986. 28p. Contract AC02-76CH03073. DE87007254 NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007254.

It is an object of the present invention to provide for improved generation and sustainment of an energetic plasma in a spheromak fusion reactor. A large poloidal magnetic flux is inductively induced in a spheromak-shaped plasma utilizing a reduced magnetic field-generating current in a current-carrying flux core.

26356 **Method and apparatus for preventing cyclotron breakdown in partially evacuated waveguide.** Moeller, C.P. (to Dept. of Energy). US Patent Application 6-818,946. 15 Jan 1986. 21p. Contract AC03-84ER51044. DE87007291 NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007291.

It is an object of this invention to provide a method and apparatus for preventing cyclotron breakdown in a partially evacuated waveguide used to insert microwave energy for electron cyclotron heating in a plasma magnetic confinement device. An electrostatic field is applied along a section of such a waveguide in order to run seed electrons into the wall of the waveguide.

26357 **Initiation of extended arc discharge in ICF reactor dense atmospheres.** Kislev, H. Urbana, IL; Univ. of Illinois (1986). 168p. University Microfilms Order No. 87-01,531.

Thesis (Ph. D.).

Reduced density plasma channels are essential for LIB transport from external diodes to an ICF pellet centered in the 2-4 MPa superheated steamfilled cavity of the Heavy Water ICF Reactor. Forming such channels by ohmic heating requires the initiation of straight arc discharges along each beamline. The goal of this thesis is to evaluate the threshold beamline preionization and applied electric field for arc initiation. The capability of several preionizers to produce a straight preionized trail is evaluated through a ten-group Boltzmann equation solver. Electron densities around 10^{17} m^{-3} could be maintained in the trail by monojoule output external preionizers. Trail preionization through the co-application of UV and CO_2 lasers appears to be the most promising technique. UV laser preionization of NO($a^4\pi$) formed in the fireball shows also good prospective. The large divergence of soft x-ray sources reduces their attractivity. The E/N dependent electron transport properties are used to construct the first streamer model capable of evaluating the steady state streamer wave shape. The streamers-induced highly ionized filament transition into a multi-kA carrying plasma channel is simulated by a modified radiation-MHD one-dimensional code.

26358 **Research with high-power short-wavelength lasers.** Holzrichter, J.F.; Campbell, E.M.; Lindl, J.D.; Storm, E. (Lawrence Livermore National Lab., CA). *Science (Washington, D.C.);* **229**: No. 4718, 1045-1051(13 Sep 1985). Contract W-7405-ENG-48.

Three high-temperature, high-density experiments were conducted recently with the 10-terawatt, short-wavelength Novette laser system at the Lawrence Livermore National Laboratory. The experiments demonstrated successful solutions to problems that arose during previous laser-plasma interaction experiments with long-wavelength (greater than 1 micrometer) lasers: (i) large-scale plasmas, with dimensions approaching those needed for high-gain inertial fusion targets, were produced in which potentially deleterious laser-plasma instabilities were collisionally damped; (ii) deuterium-tritium fuel was imploded to a density of 20 grams per cubic centimeter and a pressure of 10^{10} atmospheres under the improved laser conditions, and compression conditions (preheating and pressure) were consistent with code calculations that predict efficient (high-gain) burn of a large thermonuclear fuel mass when driven with a large, short-wavelength laser; and (iii) soft x-ray were amplified by a factor of 700 by stimulated emission at 206 and 209 angstroms (62 electron volts) from selenium ions in a laser-generated plasma. These small, short-pulse x-ray sources are 10^{10} to 10^{11} times brighter than the most powerful x-ray generators and synchrotron sources available today. The plasma conditions for these experiments were made possible by advances in Nd:glass laser technology, in techniques to generate efficiently its short-wavelength harmonics at 0.53, 0.35, and 0.26 micrometers, and in diagnostic and computational modeling. 51 references, 6 figures.

26359 **Influence of profile shape on the extraordinary-mode stability properties of relativistic non-neutral electron flow in a planar diode with applied magnetic field.** Davidson, R.C.; Tsang, K.T. (Massachusetts Institute of Technology, Cambridge). *Physics of Fluids;* **28**: No. 4, 1169-1177(Apr 1985). Contract AC02-78ET51013.

The cold-fluid extraordinary-mode eigenvalue equation is solved numerically to determine the influence of equilibrium profile shape on the detailed stability properties of relativistic non-neutral electron flow in a planar diode with cathode located at $x = 0$ and anode at $x = d$. Stability properties are investigated for the class of equilibrium energy profiles γ/sub b/(x) specified by γ/sub b/(x) = $\lambda \cosh \alpha_1 x + (1 - \lambda)$\{[1 - $\alpha_2{}^2(b^2 - x^2)$]/sup 1/2//[1 - $\alpha_2{}^2b^2$]/sup 1/2/\} over the interval $0 \leqq x \leqq b$. Here α_1 and α_2 are constants (with $a_2{}^2b^2 < 1$), $x = b$ is the outer edge of the electron layer, and λ is a constant parameter in the range of $0 \leqq \lambda \leqq 1$. The corresponding equilibrium profiles for B/sub z/(x), n/sub b/(x), and E/sub x/(x) are determined self-consistently from the steady-state ($\delta/\delta t = 0$) cold-fluid-Maxwell equations. As the parameter λ is varied from unity to zero there is a large change in the equilibrium profile for n/sub b/(x)/γ/sub b/(x), ranging from n/sub b/(x)/γ/sub b/(x) = constant over the interval $0 \leqq x < b$ when $\lambda = 1$, to monotonic decreasing profiles for n/sub b/(x)/γ/sub b/(x) when $\lambda < 1$. The numerical analysis of the extraordinary-mode eigenvalue equation shows that the detailed stability properties are very sensitive to the shape of the equilibrium profiles. As λ is reduced from unity, and the profile for n/sub b/(x)/γ/sub b/(x) becomes monotonic decreasing, it is found that the instability growth rate Im omega is reduced. Moreover, the more rapid the decrease in n/sub b/(x)/γ/sub b/(x) (i.e., the smaller the value of λ), the more the growth rate is reduced. Indeed, in some parameter regimes, the instability growth rate can be reduced to zero over the range of wavenumber k examined numerically. 18 references, 9 figures.

26360 **Recent developments in neutron dosimetry and damage calculations for fusion materials irradiations.** Greenwood, L.R.; Smither, R.K. (Argonne National Lab., IL). pp 251-261 of Reactor dosimetry. Genthon, J.P.; Roettger, H. (eds.). Brussels, Belgium; ECSC, EEC, EAEC (1985).

Fusion materials experiments require accurate neutron dosimetry measurements and damage calculations. Neutron cross section measurements are described for application at fission reactors, accelerator neutron sources, fusion reactors, and spallation neutron sources. For fission reactors work is in progress to resolve integral/differential discrepancies and to develop new reactions for dosimetry. Reactions for fusion reactors are being used for plasma diagnostics and waste generation. Spallation reactions are being measured to extend our techniques to 800 MeV for spallation neutron sources. The spectra computer code has been developed to routinely calculate displacement damage, gas production, recoil spectra, and total dose for 38 elements for any user-specified neutron spectrum. New helium measurements and calculations are described. A new procedure is discussed for the thermal production of helium by nickel including previously neglected damage from the energetic ^{56}Fe recoils. 24 references, 4 figures.

26361 **Self-sustaining systems of reactors.** Spinrad, B.I. (Dept. of Nuclear Engineering, Oregon State Univ., Corvallis). pp 51-66 of Nuclear technologies in a sustainable energy system. Bauer, G.S.; Mc Donald, A. New York, NY; Springer-Verlag New York Inc. (1983).

Nuclear fission is capable of making a very large contribution to world energy needs. This capability rests on the assumption that the nuclear fuel supply can be sustained by using a mixture of reactor types (mainly advanced converters and breeders). In this way an inventory of available fissile material can be maintained with almost trivial inputs of freshly-mined uranium and thorium. To use the nuclear energy to its best advantage, a diversity of end uses should also be considered, including the following: central-station electricity and process-heat parks; dispersed electrical stations to serve dispersed major electricity consumers such as urban centers and large, fixed-site industries; process-heat sources for secondary fuel production from coal or biomass; total energy systems for remote settlements; and marine, space, and other special uses.

26362 **The fusion breeder: Its potential role and prospects.** Lee, J.D. (Lawrence Livermore National Lab., Livermore, CA). pp 121-136 of Nuclear technologies in a sustainable energy system. Bauer, G.S.; Mc Donald, A. New York, NY; Springer-Verlag New York Inc. (1983).

The fusion breeder concept utilizes 14-MeV neutrons from DT fusion reactions to produce more neutrons than are required to breed the tritium needed to sustain the fusion process; this excess is used to produce fissile fuel for subsequent use in fission reactors. The historical development of and motivation for the fusion breeder are described and a number of conclusions drawn about the possible future role of such a device. First, it could significantly influence the development of both fission and fusion plants by allowing fission to meet demand with a variety of reactor types and by acting as an early commercial fusion application. Second, if serious development work starts now, the device could be ready relatively quickly and in time to avert some of the energy/environment problems foreseen for the 21st century. Third, the concept seems economically favorable, would set a ceiling to U/sub 3/O/sub 8/ prices, and could show a very high benefit/cost ratio. Finally, the device would give power utilities the option of just buying fissile fuel as they do at present from enrichment plants.

26363 **Design of neutron streak camera for fusion diagnostics.** Wang, C.L.; Kalibjian, R.; Singh, M.S. (Lawrence Livermore National Lab., CA). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **348**: 276-280(1982). Contract W-7405-ENG-48.

The D-T burn time for advanced laser-fusion targets is calculated to be very short, < 50 ps. The authors describe the design of a neutron streak camera of 16 ps resolving time that can be used to study the temporal history of fusion burn. The cathode of the neutron streak camera is sensitive to neutrons and is curved such that the difference in the neutron path lengths from a point source to various parts of the cathode is compensated by electron transit times within the streak tube. Thus the cathode can be made large for high sensitivity, without sacrificing time resolution. The cathode is coated with 1 μm UO_2. Each fission fragment leaving the cathode generates 400 secondary electrons that are all < 20 eV. These electrons are focussed to a point with an extractor and an anode, and are then purified with an electrostatic deflector. The electron beam is streaked and detected with the standard streak camera techniques. Careful shielding is needed for x-ray from the fusion target and general background. It appears that the neutron streak camera can be a viable and unique tool for studying temporal history of fusion burns in D-T plasmas of a few keV ion temperature. 3 references, 5 figures, 1 table.

99 GENERAL AND MISCELLANEOUS

26364 (DOE/ER—0304) Manpower assessment brief: energy-related employment projected to decline from 1986 to 1991. (Oak Ridge Associated Universities, Inc., TN (USA)). Nov 1986. Contract AC05-76OR00033. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008005.

This manpower brief summarizes the employment implications of projected energy trends for scientists and engineers involved in primary energy/fuel (coal, oil and gas, nuclear, renewable energy, and fossil fuel utilities) production and distribution and energy-related R & D funded by the US Department of Energy (DOE), US Environmental Protection Agency (EPA), and US Nuclear Regulatory Commission (NRC) and the private sector. Total energy-related workers (based on data from the first quarter of the year) number an estimated 2.24 million in 1986, including an estimated 69,500 scientists and 145,000 engineers. This compares to an estimated 2.36 million energy-related workers in 1985 and 2.31 million in 1983.

26365 (DOE/ER—0308) Manpower assessment brief: Employment of energy related doctoral scientists and engineers increased between 1981 and 1985. (Oak Ridge Associated Universities, Inc., TN (USA)). Jan 1987. Contract AC05-76OR00033. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87008006.

In 1985, the nearly 45,000 energy-related doctoral scientists and engineers represented 11% of all employed doctoral scientists and engineers. Engineers comprised 40%, physical scientists, 21%, and earth scientists, almost 10% of those involved in energy-related activities - a significantly different distribution than occurs among all Ph.D. scientists and engineers. Between 1981 and 1985, by far the largest increase in energy-related Ph.D.'s occurred in employment in the life sciences - up over 120%. Employment in the social sciences and pyschology (primarily the latter) grew by 17% and in engineering by 7%.

9901 Management

REFER ALSO TO CITATION(S) 26386

26366 (DOE/OR/00033—T293) Fossil energy research participation program: Annual report, FY1986. (Oak Ridge Associated Universities, Inc., TN (USA)). Feb 1987. Contract AC05-76OR00033. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007655.

The US Department of Energy's (DOE) Fossil Energy Research Participation program provides opportunities and support for research and training in advanced fossil energy technologies and procedures and access to modern fossil energy research facilities. There are separate elements of the program for undergraduate and graduate students, postgraduates, and faculty members from institutions of higher education. A number of the programs contain a part-time component designed to attract persons within commuting distance of the facilities who are unable to participate on a full-time basis. Two DOE Energy Technology Centers (Morgantown and Pittsburgh) participated in the program in FY1986. The US Bureau of Mines, Pittsburgh Research Center (PRC) also had minor participation in the programs.

26367 (ORAU—276) Oak Ridge Associated Universities institutional plan: FY 1987-FY 1992. (Oak Ridge Associated Universities, Inc., TN (USA)). Mar 1987. Contract AC05-76OR00033. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007656.

The current programs of Oak Ridge Associated Universities (ORAU) promote collaborative research, education and training, curriculum development and assessment, policy studies, and technical assistance involving universities, industry and government. Most of its collaborative work with academe and government laboratories is funded through its US Department of Energy (DOE) Management and Operating (M and O) contract. However, some of its work under the DOE contract is sponsored by private sector funding from organizations such as the Electric Power Research Institute and the Gas Research Institute. Other work is funded strictly through grants to ORAU under its 501 (c) 3 tax-exempt status.

26368 (ORNL/TM—10320) The success or failure of management information systems: A theoretical approach. Curlee, T.R.; Tonn, B.T. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 80p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE87007802.

Work has been done by various disciplines to address the reasons why modern, computerized management information systems either succeed or fail. However, the studies are not based on a well-defined conceptual framework and the focus has been narrow. This report presents a comprehensive conceptual framework of how an information system is used within an organization. This framework not only suggests how the use of an information system may translate into productivity improvements for the implementing organization but also helps to identify why a system may succeed or fail. A major aspect of the model is its distinction between the objectives of the organization in its decision to implement an information system and the objectives of the individual employees who are to use the system. A divergence between these objectives can lead to system underutilization or misuse at the expense of the organization's overall productivity.

9902 Mathematics And Computers

REFER ALSO TO CITATION(S) 24545

26369 (AD-A—175776/4/XAB) Logic simulation on a multiprocessor. Master's thesis. Bradley, E. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Computer Science). Nov 1986. 97p. (MIT/LCS—380). NTIS, PC A05/MF A01.

The performance of circuit simulators running on SISD computers is fundamentally limited by the Von Neumann bottleneck. Multiprocessors do not share this limitation. The task of solving the equations for the many parallel signal paths found in most circuits lends itself readily to concurrent computation. For both of these reasons, parallel processing is a highly promising approach to circuit simulation. This thesis explores several facets of this problem. The logic simulator CONSIM was implemented in the parallel language Multilisp, which contains special constructs for dispatching tasks in parallel. A model for the simulator's behavior was developed using a series of experiments. The analysis explains the effects upon CONSUM's performance of several parameters, including: the number of nodes in the multiprocessor, circuit size and topology, and the algorithms for generating the simulation code and for taking advantage of its inherent parallelism. The final generation of these algorithms exposed and exploited significant parallelism, but did not attain linear speedup.

26370 (AD-A—176114/7/XAB) Efficient distributed algorithm for maximum matching in general graphs. Technical report. Wu, M.C. (Illinois Univ., Urbana (USA). Applied Computation Theory Group). Jan 1987. 65p. (ACT—73). NTIS, PC A04/MF A01.

Let G = (V, E) be a finite, undirected, connected graph with the set of vertices V and the set of edges E. A matching M is a subset that no two edges of M are incident on a common vertex. A maximum matching is a matching of maximum cardinality. This thesis presents an efficient distributed algorithm for finding a maximum matching in a general graph. In designing his distributed matching algorithm, the author is concerned with the communication complexity. The maximum number of message transmissions determines the efficiency of the algorithm. He concentrates on minimizing the number of messages for two reasons. First, in an actual distributed system, the communication time would likely be much greater than the processing time. Second, in commercial computer networks, common carriers often charge by the number of packets or bits rather than by time.

26371 **(AD-A—176186/5/XAB) Development and simulation of synergistically integrated reliability (SIR) for an ultra-reliable fault-tolerance computer under communication software protocol for the growth algorithm. Master's thesis.** Sudhamasapa, N. (Naval Postgraduate School, Monterey, CA (USA)). Sep 1986. 112p. NTIS, PC A06/MF A01.

This thesis describes a C language implementation of the GROWTH ALGORITHM computer program to manage a fault-tolerant computer communication network. Simulation tools are developed to verify and validate the operation of the GROWTH ALGORITHM, and concepts are developed to evaluate the performance of the communication network.

26372 **(AD-A—176290/5/XAB) Parallel (delta + 1) coloring of constant-degree graphs.** Goldberg, A.V.; Plotkin, S.A. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Computer Science). Dec 1986. 9p. (VLSI-MEMO—86-355). NTIS, PC A02/MF A01.

This paper presents parallel algorithms for coloring a constant-degree graph with a maximum degree of delta in (delta + 1) colors and for finding a maximal independent set in a constant-degree graph. Given a graph with n vertices, the algorithms run in O (lg*n) time on EREW PRAM with O(n) processors. The algorithms use only local communication and achieve the same complexity bounds when implemented in the distributed model of parallel computation.

26373 **(ANL—87-7) Beyond "Speedup": Performance analysis of parallel programs.** Dritz, K.W.; Boyle, J.M. (Argonne National Lab., IL (USA)). Feb 1987. Contract W-31109-ENG-38. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007954.

This paper addresses the problem of measuring and analyzing the performance of fine-grained parallel programs running on shared-memory multiprocessors. Such processors use locking (either directly in the application program, or indirectly in a subroutine library or the operating system) to serialize accesses to global variables. Given sufficiently high rates of locking, the chief factor preventing linear speedup (besides lack of adequate inherent parallelism in the application) is lock contention - the blocking of processes that are trying to acquire a lock currently held by another process. We show how a high-resolution, low-overhead clock may be used to measure both lock contention and lack of parallel work. Several ways of presenting the results are covered, culminating in a method for calculating, in a single multiprocessing run, both the speedup actually achieved and the speedup lost to contention for each lock and to lack of parallel work. The speedup losses are reported in the same units, "processor-equivalents," as the speedup achieved. Both are obtained without having to perform the usual one-process comparison run. We chronicle also a variety of experiments motivated by actual results obtained with our measurement method. The insights into program performance that we gained from these experiments helped us to refine the parts of our programs concerned with communication and synchronization. Ultimately these improvements reduced lock contention to a negligible amount and yielded nearly linear speedup in applications not limited by lack of parallel work. We describe two generally applicable strategies ("code motion out of critical regions" and "critical-region fissioning") for reducing lock contention and one ("lock/variable fusion") applicable only on certain architectures.

26374 **(ANL/MCS-TM—81) An extended set of Fortran Basic Linear Algebra Subprograms: model implementation and test programs.** Dongarra, J.J.; Du Croz, J.; Hammarling, S.; Hanson, R.J. (Argonne National Lab., IL (USA)). Jan 1987. Contract W-31109-ENG-38. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE87007913.

This paper describes a model implementation and test software for the Level 2 Basic Linear Algebra Subprograms (Level 2 BLAS). The Level 2 BLAS are targeted at matrix-vector operations with the aim of providing more efficient, but portable, implementations of algorithms on high-performance computers. The model implementation provides a portable set of Fortran 77 Level 2 BLAS for machines where specialized implementations do not exist or are not required. The test software aims to verify that specialized implementations meet the specification of the Level 2 BLAS and that implementations are correctly installed.

26375 **(BDX—613-3741) Computer programs for nonlinear least squares analysis of various three-dimensional geometrical elements.** Drake, S.R. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). Apr 1987. Contract AC04-76DP00613. 149p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE87008046.

The nonlinear mathematics and the corresponding computer programs are presented for least squares fitting a line, plane, circular cylinder, circular cone, ring, and toroid all in three dimensions where the perpendicular residuals were minimized. The computer programs also include self-checking routines.

26376 **(CONF-8608164—1) Uniqueness of non-negative solutions of a class of semi-linear elliptic equations.** Kaper, H.G.; Kwong, M.K. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 12p. NTIS, PC A02. File Number DE87006966.

From Microprogram on nonlinear diffusion equations and their equilibrium states; Berkeley, CA, USA (25 Aug 1986).

This article is concerned with boundary value problems (BVP) of the type $u'' + g(r)u' + f(u) = 0$, $r > 0$; $u'(0) = 0$, lim/ sub $r \to \infty$/u(r) = 0; where $f(0) = 0$. Such problems arise in the study of semi-linear elliptic differential equations in R/sup n/. It is shown that (BVP) has at most one non-negative non-trival solution under appropriate conditions on f and g. The conditions are weaker than those given by Peletier and Serrin [J. Diff. Eq. 61 (1986), 380-397], who considered the special case $g(r) = (n-1)/r$, $n = 2,3,...$

26377 **(DOE/ER/25009—391) The hypercube as a supercomputer.** Fox, G.C. (California Inst. of Tech., Pasadena (USA)). 1987. Contract FG03-85ER25009;AC03-81ER40050. 22p. (CONF-870567—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87005029.

From 2. international conference on supercomputing; San Francisco, CA, USA (1 May 1987).

We show that a hypercomputer is a relatively general purpose supercomputer that can address a wide variety of fields. We describe both the general issues and specific examples that have been developed at Caltech. We review some of the software tools that can help the development of code for such concurrent computers. 46 refs., 7 figs.

26378 **(HEDL-SA—3299-FP) Software verification for nuclear industry.** Wilburn, N.P. (Hanford Engineering Development Lab., Richland, WA (USA)). Aug 1985. Contract AC06-76FF02170. 9p. (CONF-850903—29). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87004343.

From International topical meeting on computer applications for nuclear power plant operation and control; Pasco, WA, USA (8 Sep 1985).

Why verification of software products throughout the software life cycle is necessary is considered. Concepts of verification, software verification planning, and some verification methodologies for products generated throughout the software life cycle are then discussed.

26379 **(LA-UR—87-805) Future directions of C3 research at DARPA [Defense Advanced Research Projects Agency].** Perry, D.G.; Dahmann, J.S. (Defense Advanced Research Projects Agency, Arlington, VA (USA). Information Science and Technology Office; Los Alamos National Lab., NM (USA); Mitre Corp., Bedford, MA (USA)). 1987. Contract W-7405-ENG-36. 11p. (CONF-870271—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87007501.

From European AFCEA meeting; Brussels, Belgium (16 Feb 1987).

Research into C3 related problems is a major effort of the Information Science and Technology Office of the Defense Advanced Research Projects Agency. The major thrusts of projects is in the area of future, high-risk efforts, often resulting in the development of a conceptual model or prototype. Some of these prototypes are then further developed to provide an infrastructure for future research. The programs can be divided into two groups: base technology research programs and testbed programs. The testbeds provide a focus for the technology programs.

26380 **(LA-UR—87-811) Distributed data access in the LAMPF [Los Alamos Meson Physics Facility] control system.** Schaller, S.C.; Bjorklund, E.A. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 4p. (CONF-870302—35). NTIS, PC A02. File Number DE87007498.

From Particle accelerator conference; Washington, DC, USA (16 Mar 1987).

We have extended the Los Alamos Meson Physics Facility (LAMPF) control system software to allow uniform access to data and controls throughout the control system network. Two aspects of this work are discussed here. Of primary interest is the use of standard interfaces and standard messages to allow uniform and easily expandable inter-node communication. A locally designed remote procedure call protocol will be described. Of further interest is the use of distributed databases to allow maximal hardware independence in the controls software. Application programs use local partial copies of the global device description database to resolve symbolic device names.

26381 **(LA-UR—87-1036) Integral approximants for functions of higher monodromic dimension.** Baker, G.A. Jr. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 30p. (CONF-870492—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007508.

From Nonlinear numerical methods and rational approximation conference; Antwerp, Belgium (20 Apr 1987).

In addition to the description of multiform, locally analytic functions as covering a many sheeted version of the complex plane, Riemann also introduced the notion of considering them as describing a space whose "monodromic" dimension is the number of linearly independent coverings by the monogenic analytic function at each point of the complex plane. I suggest that this latter concept is natural for integral approximants (sub-class of Hermite-Pade approximants) and discuss results for both "horizontal" and "diagonal" sequences of approximants. Some theorems are now available in both cases and make clear the natural domain of convergence of the horizontal sequences is a disk centered on the origin and that of the diagonal sequences is a suitably cut complex-plane together with its identically cut pendant Riemann sheets. Some numerical examples have also been computed.

26382 **(LA-UR—87-1038) Improving productivity with a CCC tool kit.** Cort, G. (Los Alamos National Lab., NM (USA)). 1987. Contract W-7405-ENG-36. 9p. (CONF-8703102—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87007507.

From Softool User's Group spring meeting; Santa Barbara, CA, USA (30 Mar 1987).

A typical utility macro tool set is described. Included are SIMPORT and SEXPORT that provide syntax-directed import and export, EDIT-HOST which permits CCC resident texts to be edited with a host editor, INITIATE-LOGIN which automatically executes a hierarchy of user- and manager-defined login texts, and BATCH whicn permits CCC macros to be executed in batch mode from within CCC.

26383 **(LBL—22460) The future of intersite networking.** (Lawrence Berkeley Lab., CA (USA)). Nov 1986. Contract AC03-76SF00098. 361p. (CONF-8610138—Summs.). NTIS, PC A16. File Number DE87007912.

From 1. annual energy research workshop on interlaboratory computing; Berkeley, CA, USA (27 Oct 1986).

Copies of viewgraphs and summaries of three discussion groups are presented. The purpose of the workshop was to identify strategies for meeting the computer networking needs to the scientists under the Office of Energy Research. (WRF)

26384 **(ORNL/TM—10323) Gaussian elimination with partial pivoting and load balancing on a multiprocessor.** George, A.; Chu, E. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007784.

A row-oriented implementation of Gaussian elimination with partial pivoting on a local-memory multiprocessor is described. In the absence of pivoting, the initial data loading of the node processors leads to a balanced computation. However, if interchanges occur, the computational loads on the processors may become unbalanced, leading to inefficiency. A simple load balancing scheme is described which is inexpensive and which maintains computational balance in the presence of pivoting. Using some reasonable assumptions about the probability of pivoting occurring, an analysis of the communication costs of the algorithm is developed, along with an analysis of the computation performed in each node processor. This model is then used to derive the expected speed-up of the algorithm. Finally, experiments using an Intel iPSC hypercube are presented in order to demonstrate the extent to which the analytical model predicts the performance. 11 refs., 2 tabs.

26385 **(ORNL/TM—10383) LU factorization algorithms on distributed-memory multiprocessor architectures.** Geist, G.A.; Romine, C.H. (Oak Ridge National Lab., TN (USA)). Mar 1987. Contract AC05-84OR21400. 31p. NTIS, PC A03. File Number DE87007794.

In this paper, we consider the effect that the data storage scheme and pivoting scheme have on the efficiency of LU factorization on a distributed-memory multiprocessor. Our presentation will focus on the hypercube architecture, but most of our results are applicable to distributed-memory architectures generally. We restrict our attention to two commonly used storage schemes (storage by rows and by columns) and investigate partial pivoting both by rows and by columns, yielding four factorization algorithms. The goal is to determine which of these four algorithms admits the most efficient parallel implementation. We analyze factors such as load distribution, pivoting cost, and potential for pipelining. We conclude that, in the absence of loop unrolling, LU factorization with partial pivoting is most efficient when pipelining is used to mask the cost of pivoting. The two schemes that can be pipelined are pivoting by interchanging rows when the coefficient matrix is distributed to the processors by columns, and pivoting by interchanging columns when the matrix is distributed to the processors by rows.

26386 **(SAND—86-2543C) Considerations in developing a comprehensive computer security support database system.** Clever, J.J. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 18p. (CONF-870565—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE87005527.

From Department of Energy computer security group conference; Albuquerque, NM, USA (5 May 1987).

In the past several years, computer technology has mushroomed on all fronts. This has resulted in the computer security professional encountering the problem of an ever increasingly complex demand for control, audit, and countermeasure efforts, with concomitantly greater demands on scarce personal time. This paper examines the background of the problem in the practical context of an existing larger organization. It then looks at some of the managerial, technical and economic considerations involved in achieving a higher level of individual productivity at minimal personnel costs. In this instance, the methodology reviewed considerations for developing involves support from an automated database. Finally, it provides an overview of the database schema, a summary of the initial applications design, and a review of some concerns encountered at implementation of the concept.

26387 **(SAND—86-2917) Parameter optimization capability in the trajectory code PMAST [Point-Mass Simulation Tool].** Outka, D.E. (Sandia National Labs., Albuquerque, NM (USA)). 28 Jan 1987. Contract AC04-76DP00789. 64p. NTIS, PC A04. File Number DE87007434.

Trajectory optimization capability has been added to PMAST through addition of the Recursive Quadratic Programming code VF02AD. The scope of trajectory optimization problems the resulting code can solve is very broad, as it takes advantage of the versatility of the original PMAST code. Most three-degree-of-freedom flight-vehicle problems can be simulated with PMAST, and up to 25 parameters specifying initial conditions, weights, control histories and other problem-deck inputs can be used to meet trajectory constraints in some optimal manner. This report outlines the mathematical formulation of the optimization technique, describes the input requirements and suggests guidelines for problem formulation. An example problem is presented to demonstrate the use and features of the optimization portions of the code.

26388 **(SAND—87-0206) Numerical prediction of 1-D ablation using a finite control volume procedure with exponential differencing.** Blackwell, B.F. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1987. Contract AC04-76DP00789. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007947.

The exponential differencing scheme of Spalding, which has been used for convection problems, is adapted to solve one-dimensional ablation problems by using a grid attached to the receding surface. Using the Finite Control Volume approach, element conduction, convection, and storage matrices are developed. The method is applied to a steady state ablation problem for which an analytical solution is known; comparisons are also made with upwind differencing for the convection terms and central differencing for the conduction terms. An example of a realistic ablation problem is presented.

26389 **(SAND—87-0369) DATA: A comprehensive data analysis environment for HP1000 computers.** Drotning, W.D. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1987. Contract AC04-76DP00789. 42p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE87007824.

DATA was designed to accomplish a wide variety of tasks related to analysis of data stored in files on Hewlett-Packard HP 1000 minicomputer systems. As a data analysis tool, DATA provides a number of often-used mathematical analysis and data manipulation functions which may be employed. Flexible file structures, on both input and output, are allowed. An editor is included which allows DATA to serve as a binary file editor for data; search routines based on numeric, rather than string, values are incorporated. Graphical plotting of data and functions, cursor selection of specific data regions, and other graphics features are also included. DATA also serves as a shell operating system, with direct interface to the RTE operating system. Commonly-used file management functions are incorporated or enhanced for operator convenience. DATA is both command and menu (softkey) driven, and on-line help facilities are included. Finally, DATA serves as a common framework for future expansion, such as incorporation of the IMSL library or additional user-defined functions.

26390 **(SAND—87-0516C) Hawk: An operating system kernel for a real-time embedded multiprocessor.** Holmes, V.P.; Harris, D.L.; Piorkowksi, K.W.; Davidson, G.S. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 9p. (CONF-870574—1). NTIS, PC A02. File Number DE87006707.

From Computing conference; Anaheim, CA, USA (1 May 1987).

The Hawk operating system is a real-time multitasking environment for the SANDAC V, a Motorola 68020-based multiprocessor. This system is presented with respect to general target applications, the underlying multiprocessor hardware and the programming abstractions useful for real-time problems. The design principles, system features and user interface are discussed, together with an evaluation of the success of the Hawk effort and its usefulness in fielded application.

26391 **(SAND—87-0587C) The use of real-time optical processors in embedded computing.** Stalker, K.T.; Molley, P.A.; Stichman, J.H.; Humphreys, S.L. (Sandia National Labs., Albuquerque, NM (USA)). 1987. Contract AC04-76DP00789. 10p. (CONF-870574—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006895.

From Computing conference; Anaheim, CA, USA (1 May 1987).

Optical processing technology can be applied to embedded computer systems to perform specialized tasks and general computation. An overview of several processing architectures will be presented. In particular, a class of architectures which uses one-dimensional acousto-optic devices (AOD) to achieve two-dimensional processing has been studied. These architectures are applicable to radar image formation and 2-D correlation coprocessors for real-time embedded computers. Real-time radar image formation by such a system has been achieved in the laboratory with components that can be applied in an embedded computer environment. Data on the performance of this coprocessor will be presented, along with a discussion of the potential extensions of this technology to other embedded computer problems. 13 refs., 12 figs.

26392 **(UCRL—93407) UW: A Macintosh UNIX window interface.** Bruner, J.D. (Lawrence Livermore National Lab., CA (USA)). 25 Sep 1985. Contract W-7405-ENG-48. 8p. (CONF-8601114—1). NTIS, PC A02. File Number DE87008152.

From UNIX users' group spring conference; Denver, CO, USA (15 Jan 1986).

A window interface to a 4.2 BSD UNIX system has been implemented on an Apple Macintosh personal computer. This interface supports a maximum of seven independent terminal sessions, each in its own window. Each window simulates a "smart" cursor-addressible 24 x 80 terminal. The implementation requires no changes to the UNIX kernel and imposes so little overhead as to be useful even at the low baud rates of dial-up lines.

26393 **(UCRL—94113) Three dimensional graphics in the statistical analysis of scientific data.** Grotch, S.L. (Lawrence Livermore National Lab., CA (USA)). May 1986. Contract W-7405-ENG-48. 9p. (CONF-860758—2). NTIS, PC A02. File Number DE87008151.

From 13. international biometric conference; Seattle, WA, USA (28 Jul 1986).

In scientific data analysis, the two-dimensional plot has become an indispensable tool. As the scientist more commonly encounters multivariate data, three dimensional graphics will form the natural extension of these more traditional representations. There can be little doubt that as the accessibility to ever more powerful graphics tools increases, their use will expand dramatically. In using three dimensional graphics in routine data analysis for nearly a decade, they have proved to be a powerful means for obtaining insights into data simply not available with traditional 2D methods. Examples of this work, taken primarily from chemistry and meteorology, are presented to illustrate a variety of 3D graphics found to be practically useful. Some approaches for improving these presentations are also highlighted.

26394 **(UCRL—96188) Reading patterns in online documentation: How transcript analysis reflects text design, software constraints, and user preferences.** Girill, T.R.; Luk, C.H.; Norton, S. (Lawrence Livermore National Lab., CA (USA)). Feb 1987. Contract W-7405-ENG-48. 6p. (CONF-870538—4). NTIS, PC A02. File Number DE87006466.

From 34. international technical communication conference; Denver, CO, USA (10 May 1987).

Text design and text-delivery software together influence the effectiveness of online computer documentation. To explore this relationship, we analyzed transcripts for a typical month of sessions in which users of a supercomputer network consulted online documentation by means of very flexible software. We found that most readers displayed relatively small passages from single documents, often checking a subject index to select those passages. This strong reference-reading pattern confirms and clarifies results from other, more limited studies of online text use. The reference pattern appears even stronger when users accessed task-oriented documents that included many examples.

26395 **Approximation of Weiner integrals.** Hald, O.H. (Department of Mathematics, University of California, Berkeley, California 94720). *Journal of Computational Physics;* **69**: No. 2, 460-470(Apr 1987).

We present a new proof of Chorin's quadrature formula for Weiner integrals. Numerical experiments show that the rate of convergence may not be quadratic, if the functional is not twice differentiable. copyright 1987 Academic Press, Inc.

26396 **LBL computing newsletter.** *LBL Computing Newsletter;* **22**: No. 7, 1-20(Jul 1985). Contract AC03-76SF00098.

The LBL Computing Newsletter for July, 1985 summarizes information relating to the use of LBL computing facilities. Topics covered include 8600 VMS printers, electronic mail, CSA2, DECnet and several other systems. A section on personal computers is included which discusses discounts on computers and software.

26397 **LBL computing newsletter.** *LBL Computing Newsletter;* **22**: No. 2, 1-18(Feb 1985). Contract AC03-76SF00098.

The LBL Computing Newsletter for February, 1985 summarizes information relating the the use of LBL computing facilities. Topics covered include terminals and screen management on VAX/VMS V 4.0, UNIX, Berkeley ISP and modems. A section on personal computers is included.

26398 **Supercomputers and distributed computing.** Kuck, D.J. (Dept. of Computer Science, Univ. of Illinois). pp 34-46 of Proceedings of ACM 13th annual computer science conference. New York, NY; Association for Computing Machinery (1985). (CONF-8503270—).

From 13. ACM annual computer science conference; New Orleans, LA, USA (12 Mar 1985).

Multiprocessor supercomputers and distributed systems share many common properties in a logical sense. The physical implementation of these systems may be quite different, particularly with respect to timing considerations. Some of the recent work on supercomputer hardware and software may be of use in the distributed processing community. The author discuss some aspects of how to relate program and data structures to architectural models.

26399 **Measurement, management and optimization.** Michelson, R. (Computer User Services Group, Los Alamos National Lab., Los Alamos, NM 87544). pp 150 of Proceedings of ACM 13th annual computer science conference. New York, NY; Association for Computing Machinery (1985). (CONF-8503270—).

From 13. ACM annual computer science conference; New Orleans, LA, USA (12 Mar 1985).

The abundance of literature devoted to the topics of measurement, management and optimization of digital systems is ample evidence of their vital importance in computing research. The papers in this session treat the issues of processor utilization measurement and file partitioning to enhance search performance. Richard W. Moulton presents a method for the characterization of processor utilization. The approach is designed to be self-calibrating, thereby providing independence from the many variables that have an impact on processor performance. An implementation of the method in a real-time control system is also described. On a slightly different not, Yuan Y. Sung discusses the issue of distributing a file across a set of devices to minimize the query response time. A restriction of this general problem is defined and an accompanying distribution method is presented. This method is analyzed with respect to query resolution performance and contrasted with several other approaches.

26400 **Information systems performance measurement and evaluation.** Anderson, J.W. (Computer User Services, Los Alamos National Lab., Los Alamos, NM 87545). pp 184 of Proceedings of ACM 13th annual computer science conference. New York, NY; Association for Computing Machinery (1985). (CONF-8503270—).

From 13. ACM annual computer science conference; New Orleans, LA, USA (12 Mar 1985).

This paper describes an automated information system for a network that includes NASA headquarters and ten NASA centers. The goals and objectives of the system and an evaluation technique that can be used to determine how well the goals and objectives are met are discussed. The primary tools proposed are software monitors embedded in the system which will gather system performance statistics.

26401 **User/system interfaces and natural language processing.** Michelsen, C.D. (Administrative Data Processing Div., Los Alamos National Lab.). pp 271 of Proceedings of ACM 13th annual computer science conference. New York, NY; Association for Computing Machinery (1985). (CONF-8503270—).

From 13. ACM annual computer science conference; New Orleans, LA, USA (12 Mar 1985).

This session consists of three papers that discuss various aspects of user/system interfaces and natural language processing. Topics to be addressed will include rapid prototyping, windowing, and natural language processing for a relational database management system. The first paper presents a description of the design of the Graphical User Interface DEsign System (GUIDES) for rapid-prototyping and testing of user interfaces. GUIDES utilizes a graphics editor and a user interface management system (UIMS) for the design and maintenance of user interfaces. An overview and evaluation of windowing is presented in the next paper. Windowing and windowing operations are first defined and then evaluated with respect to how four specific task-aid criteria and five memory-aid criteria are met utilizing windowing. The paper also includes a comparison of windowing, menus, and command languages with respect to the specified task and memory aids. The last paper discusses the implementation of a schema-driven natural-language processor. This processor, Mnemos, utilizes an augmented schema to process natural language queries.

26402 **Some parallel banded system solvers.** Dongarra, J.J.; Sameh, A.H. (Argonne National Lab., IL). *Parallel Computing;* **1**: No. 3-4, 223-235(Dec 1984). Contract W-31-109-ENG-38.

This paper describes algorithms for solving narrow banded systems and the Helmholtz difference equations that are suitable for multiprocessing systems. The organization of the algorithms highlight the large grain parallelism inherent in the problems. 13 references, 5 tables.

26403 **Everyday application of the cell means model.** Schmoyer, R.L. (Oak Ridge National Lab., TN). *American Statistician;* **38**: No. 1, 49-52(Feb 1984). Contract W-7405-ENG-26.

Statistical computer packages that routinely generate the functional form of estimable functions help the user to understand better the difference between the various similar hypotheses in an unbalanced analysis of variance. Another way to understand different hypotheses is to consider estimable functions expressed in terms of cell means. This article proposes routinely generating cell means estimable functions and gives a formula for translating estimable functions in a given parameterization to the cell means equivalent and vice versa. The authors discuss an example. 7 references, 1 table.

26404 **Computation of the polygamma functions.** Bowman, K.O. (Oak Ridge National Lab., TN). *Communications in Statistics. Part B: Simulation and Computation;* **13**: No. 3, 409-415(1984). Contract W-7405-ENG-26.

An algorithm is presented for computing the psi(digamma) and other polygamma functions. 12 references, 2 tables.

26405 **Estimation of sparse Hessian matrices and graph coloring problems.** Coleman, T.F.; More, J.J. (Cornell Univ., Ithaca, NY). *Mathematical Programming;* **28**: 243-270(1984). Contract W-31-109-ENG-38.

Large scale optimization problems often require an approximation to the Hessian matrix. If the Hessian matrix is sparse then estimation by differences of gradients is attractive because the number of required differences is usually small compared to the dimension of the problem. The problem of estimating Hessian matrices by differences can be phrased as follows: Given the sparsity structure of a symmetric matrix A, obtain vectors d_1, d_2,...,d/sub p/ such that Ad_1, Ad_2,...,Ad/sub p/ determine A uniquely with p as small as possible. The authors approach this problem from a graph theoretic point of view and show that both direct and indirect approaches to this problem have a natural graph coloring interpretation. The complexity of the problem is analyzed and efficient practical heuristic procedures are developed. Numerical results illustrate the differences between the various approaches. 13 references, 4 figures.

26406 **Data analysis: history and prospects.** Tukey, J.W. (Princeton Univ., NJ). pp 183-202 of Statistics: an appraisal of the proceedings 50th anniversary conference Iowa State Statistical Laboratory. David, H.A.; David, H.T. (eds.). Ames, IO; Iowa State University Press (1984).

The authors summarize the essentials of exploratory data analysis and the major demands upon its arithmetic processes and graphical displays. Then they look briefly at recent progress in techniques in a variety of broad fields such as single samples, two-way tables, and display of multiple responses. Finally they ask about the import of increasing diversity of techniques - in particular from robustness and exploration - on how hard it has to be for journey people and greenhorns to learn enough to be helpful. The relatively near-term accessibility of user-aiding, automatically data-exploring systems may make, for the first time, the training of greenhorns feasible.

26407 **Conference on forefronts of large-scale computational problems.** Buzbee, B.L.; Raveche, H.J. (Los Alamos National Lab., NM). *Parallel Computing;* **1**: 307-315(1984).

The application areas covered in this program, included medical imaging, materials science, pharmacology, biotechnology, physics, chemical synthesis, structural analysis, economics, fluid mechanics and movies. Recent advances obtained from large-scale computation in such diverse topics as voltage characteristics in semiconductors devices, bone reconstruction in surgery, action of drug molecules at receptor sites, interaction of DNA with water, global economic modeling and testing laws of nuclear physics were illustrated. The presentations revealed that exciting breakthroughs are possible in these areas if sufficient computing capability is forthcoming. Providing this new capability will require sizeable advances in state-of-the-art computing technology.

9903 Information Handling

REFER ALSO TO CITATION(S) 25360, 25431, 26370

26408 **(CONF-870538—1) Eternal triangle: author, editor, reader.** Nestor, M.B. (Oak Ridge National Lab., TN (USA). Fusion Energy Div.). 1987. Contract AC05-84OR21400. 4p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87000883.

From 34. international technical communication conference; Denver, CO, USA (10 May 1987).

Once upon a time, to paraphrase Kipling, there was an author and his reader and a Tertium Quid. The third party of ambiguous status in this triangle is the editor. The relationship between author and editor, which has been widely examined, can be marked by closeness and cooperation or by distance and confrontation. The less obvious relationship between editor and reader can be marked by concern and appreciation or by indifference and scorn. Editors who are sensitive to these relationships can use their ambiguous status to serve the needs of both readers and authors; this strengthens both the communication process and the editor's position in it.

26409 **(ORNL—6365) Use of a DBMS [data base management system] to aid in the software conversion process.** Huntley, A.F.; Bryant, R.A.; Buhrmaster, M.A.; Christian, J.L.; Hume, R. (Oak Ridge National Lab., TN (USA)). Feb 1987. Contract AC05-84OR21400. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87007883.

Procedures are described that provide for the automated conversion of a screen library containing over a thousand screen display definitions to a new screen definition software package. The first step is to extract the screen definition information from the original screen package. This information is then loaded into a data base management system (DBMS). The information is manipulated as necessary and output in a format that can be utilized by the new screen package. A major benefit of the procedures developed is that a DBMS allows bulk updates of multiple screen definitions to be performed. Both the source and target screen packages provide only for the updating of individual screens. Although the procedures described apply to the problem of converting screen definitions for a specific application using the two specific screen definition software packages, the flexibility inherent in a DBMS allows its use in solving many such complex problems. The concept can be modified to allow possibilities limited only by the creativity of the DBMS users and the information contained in the data base.

26410 **(UCRL—95133) Livermore Risk Analysis Methodology: A quantitative approach to management of the risk associated with the operation of information systems.** Guarro, S.B.; Garcia, A.A.; Wood, C.C.; Prassinos, P.G. (Lawrence Livermore National Lab., CA (USA)). 14 Aug 1986. Contract W-7405-ENG-48. 18p. (CONF-8610255—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE87006828.

From Computer and communications security conference; New York, NY, USA (7 Oct 1986).

Risk assessment methods vary in nature and depth. Their application to the evaluation of information security issues should be decided on the basis of their capability to provide answers to practical and fundamental questions concerning the design and implementation of security controls in specific information systems. Quantitative risk analysis provides an objectively based approach to the problem of assessing and managing risk. As a decision making and risk assessment tool, it is not only capable of identifying potential losses that could be unacceptable for a given system, but it can be used to determine which specific security controls and countermeasures can be effective and cost justifiable. The Livermore Risk Analysis Methodology (LRAM) was developed to cover these objectives in a balanced and comprehensive way. Its model and procedures, from the identification of valuable assets to the prioritization and budgeting of proposed controls, are examined and discussed both from the technical and from the decision making/risk management perspectives.

9905 Civilian Defense

26411 **(PB—87-141446/XAB) Origin and development of the port security program. Staff study report (Final).** Bryant, D.L. (Coast Guard, Washington, DC (USA)). May 1986. 11p. NTIS, PC A02/MF A01.

The study explores the authorities exercised in the U.S. port security program, particularly as they relate to wars, national emergencies, and the transfer of the Coast Guard to the Navy under such circumstances. The Coast Guard has been responsible for the port security of the United States since the program came into being in 1917. It performed those duties during both World War I and World War II, when it was operating as a service in the Navy. In 1950, port security was made a permanent program, and the duties were assigned to the Coast Guard. Current statutes now insure that port security functions and powers shift from the Department of Transportation to the Department of the Navy simultaneously with the transfer of the Coast Guard.

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The notations in the final parentheses indicate the type of document, e.g., R for Report; the country of publication, e.g., US; and the language if other than English, e.g., In German. Tables of document types and country of publication codes appear after the indexes.

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processes applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept (e.g., Pipeline Quality Gas, see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed. Copies of DOE/TIC-7000, the Subject Thesaurus, are available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161.

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AI01-83CE30792	**Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development**	
	12:24683	DOE/CE/30792—T34-Vol.1
	Tennessee Univ., Knoxville (USA). Dept. of Forestry, Wildlife and Fisheries	
	12:24684	DOE/CE/30792—T37
	Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development	
	12:24685	DOE/CE/30792—T38
	12:24686	DOE/CE/30792—T39
	North Carolina State Univ., Raleigh (USA). Dept. of Extension Forest Resources	
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	Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development	
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	Tennessee Valley Authority, Norris (USA). Div. of Land and Economic Resources	
	12:24720	TVA/ONRED/LER—87/10
AI04-80AL13137	**Jet Propulsion Lab., Pasadena, CA (USA)**	
	12:24729	DOE/JPL—1060-89
AI05-79ET29372	**Jet Propulsion Lab., Pasadena, CA (USA)**	
	12:25724	DOE/ET/29372—5
AI05-84ER13150	**National Bureau of Standards, Washington, DC (USA). Center for Chemical Physics**	
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AI07-85ID12579	**American Society for Metals, Metals Park, OH. Energy Div.**	
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AI08-76DP00351	**National Oceanic and Atmospheric Administration, Las Vegas, NV (USA). Weather Service Nuclear Support Office**	
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AI08-78ET44802	**Geological Survey, Menlo Park, CA (USA)**	
	12:24631	USGS-OFR—86-369
AI19-81BC10525	**Naval Research Lab., Washington, DC (USA)**	
	12:24601	DOE/BC/10525—16
AI79-84BP17102	**Westinghouse Electric Corp., East Pittsburgh, PA (USA). Advanced Systems Technology Div.**	
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AM06-70RL02225	**Univ. of Washington, Seattle**	
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AS02-76DP02689	**Univ. of Rhode Island, Narragansett**	
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AS03-76ER70285	**California Univ., Davis (USA)**	
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AS03-76ET53064	**California Univ., Berkeley (USA). Electronics Research Lab.**	
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	12:26295	UCB/ERL-M—86/94
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AS03-81ER40029	**California Univ., San Diego, La Jolla, USA. Dept. of Physics; Los Alamos National Lab., LANL, NM, US**	
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AS05-78EV05855	**Florida State Univ., Tallahassee**	
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AS05-80ER10565	**Texas A & M Univ., College Station**	
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AS05-80ER10641	**North Carolina Univ., Chapel Hill (USA). Dept. of Chemistry**	
	12:24437	DOE/ER/10641—5
AS05-80ER10676	**Toledo Univ., OH (USA). Dept. of Physics and Astronomy**	
	12:26072	DOE/ER/10676—9
	12:26099	Physics Letters [Section] A 105A NO. 4-5. 212-214 (15 Oct 1984).
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AS07-83NV10354	**Texas Southern Univ., Houston (USA)**	
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AS08-84DP40197	**Rochester Univ., NY (USA). Lab. for Laser Energetics**	
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AS08-85NV10511	**Wisconsin Univ., Madison (USA). Fusion Technology Inst.**	
	12:26330	DOE/NV/10511—1
FC07-80CS40379	**Georgia Inst. of Tech., Atlanta (USA). Economic Development Lab.**	
	12:25130	DOE/CS/40379—T1
FC08-85DP40200	**Rochester Univ., NY (USA). Lab. for Laser Energetics**	
	12:26328	DOE/DP/40200—37
FC21-83FE60177	**Western Research Inst., Laramie, WY (USA)**	
	12:24394	DOE/FE/60177—2305-Vol.2
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	12:24597	DOE/FE/60177—2300
	12:24602	DOE/FE/60177—2307
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	12:24604	DOE/FE/60177—2303
FC21-83FE60181	**North Dakota Univ., Grand Forks (USA). Energy Research Center**	
	12:24456	DOE/FE/60181—115
FC21-86LC11086	**Kentucky Energy Cabinet Lab., Lexington (USA)**	
	12:24598	DOE/LC/11086—2296
FG01-80RA50307	**Brown, Vence and Associates, San Francisco, CA (USA)**	
	12:24688	DOE/RA/50307—T1
FG01-82PE70399	**Woodrow Wilson International Center for Scholars, Washington, DC (USA). Asia Program**	
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	12:24909	CONF-8511268—1
FG01-84CE30828	**ACEC Research and Management Foundation, Washington, DC (USA)**	
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FG01-84CE64780	**Unified Industries, Inc., Springfield, VA (USA)**	
	12:24900	DOE/CE/64780—T8
FG01-84CE64846	**Blue Cross and Blue Shield Association, Chicago, IL (USA)**	
	12:25094	DOE/CE/64846—T1
FG01-85CE15207	**Innovative Technology Labs., Richland, WA (USA)**	
	12:25434	DOE/CE/15207—T6
FG01-85FE60740	**East-West Center, Honolulu, HI (USA)**	
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FG01-85PE77035	**Purdue Univ., Lafayette, IN (USA)**	
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	Claremont McKenna Coll., CA (USA). Center for the Study of Law Structures	
	12:24910	DOE/PE/77035—T2
	American Enterprise Inst. for Public Policy Research, Washington, DC	
	12:24911	DOE/PE/77035—T3
	12:24912	DOE/PE/77035—T4
	12:24913	DOE/PE/77035—T5
	12:24914	DOE/PE/77035—T6
	12:24915	DOE/PE/77035—T7
	12:24916	DOE/PE/77035—T8
FG01-86CE15279	**AV-YO, Inc., Kaneohe, HI (USA)**	
	12:24754	DOE/CE/15279—T2
FG01-86CE63481	**South Middlesex Opportunity Council, Framingham, MA (USA)**	
	12:25093	DOE/CE/63481—T4

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FG02-83NE44352	**Massachusetts Dept. of Public Health, Boston (USA)**	
	12:24617	DOE/NE/44352—T2
FG02-84ER13205	**Illinois Inst. of Tech., Chicago (USA). Dept. of Chemical Engineering**	
	12:25372	CONF-860229—1
	12:25435	DOE/ER/13205—3
FG02-84ER13209	**Mount Holyoke Coll., South Hadley, MA (USA)**	
	12:25416	DOE/ER/13209—1
FG02-84ER13217	**Colorado Univ., Boulder (USA). Dept. of Chemical Engineering**	
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FG02-84ER13235	**Brown Univ., Providence, RI**	
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FG02-84ER45070	**Harvard Univ., Cambridge, MA (USA)**	
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FG02-84ER45079	**Northeastern Univ., Boston, MA**	
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FG02-84ER45090	**Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering**	
	12:25254	DOE/ER/45090—3
FG02-84ER45120	**Seton Hall Univ., South Orange, NJ (USA). Dept. of Chemistry**	
	12:25381	DOE/ER/45120—5
FG02-84ER45122	**Southern Illinois Univ., Carbondale (USA)**	
	12:25382	DOE/ER/45122—T1
FG02-84ER45131	**Pittsburgh Univ., PA (USA)**	
	12:26115	DOE/ER/45131—4
FG02-84ER45154	**Massachusetts Inst. of Tech., Cambridge (USA)**	
	12:25189	CONF-860340—16
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FG02-84ER45170	**Missouri Univ., Kansas City (USA). Dept. of Physics**	
	12:25249	CONF-861111—22
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	12:25284	DOE/ER/45170—3
FG02-84NE44507	**New York State Geological Survey, Albany (USA)**	
	12:24618	DOE/NE/44507—3
FG02-85ER13411	**Utah Univ., Salt Lake City (USA). Dept. of Chemistry**	
	12:25378	DOE/ER/13411—1
FG02-85ER13454	**Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry**	
	12:24676	DOE/ER/13454—2
FG02-85ER53207	**Colorado Univ., Boulder (USA)**	
	12:26273	DOE/ER/53207—2
FG02-86CH10261	**Red Cliff Tribal Council, Bayfield, WI (USA)**	
	12:24612	DOE/CH/10261—T1
FG02-86CH10273	**Fond Du Lac Reservation, Cloquet, MN (USA)**	
	12:24613	DOE/CH/10273—1
	12:24614	DOE/CH/10273—2
	EWA, Inc. (USA)	
	12:24615	DOE/CH/10273—3
	Migizi "Eagle" Enterprises, Cloquet, MN (USA)	
	12:24616	DOE/CH/10273—4
FG02-86CH10288	**Selma Univ., AL (USA). Div. of Natural and Applied Sciences**	
	12:25919	DOE/CH/10288—4
FG02-86ER13534	**Wisconsin Univ., Madison (USA)**	
	12:25342	DOE/ER/13534—1
FG02-86ER13539	**Wisconsin Univ., Madison (USA). Lab. of Genetics**	
	12:25867	DOE/ER/13539—1
FG02-86ER13590	**State Univ. of New York, Stony Brook (USA)**	
	12:25379	DOE/ER/13590—1
FG02-86ER13596	**Kansas State Univ., Manhattan (USA). Dept. of Physics**	
	12:26071	CONF-8508100—3
	Joint Inst. for Lab. Astrophysics, Boulder, CO (USA)	
	12:26075	DOE/ER/13596—3
	Kansas State Univ., Manhattan (USA). Dept. of Physics	
	12:26076	DOE/ER/13596—7
FG02-86ER45261	**Massachusetts Inst. of Tech., Cambridge (USA). Crystal Physics and Optical Electronics Lab.**	
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FG02-86ER60455	**Oakland Univ., Rochester, MI (USA). Dept. of Chemistry**	
	12:25945	DOE/ER/60455—1
FG02-87ER60542	**Society of Nuclear Medicine, New York (USA)**	
	12:25905	DOE/ER/60542—T1
FG03-85ER25009	**California Inst. of Tech., Pasadena (USA)**	
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FG03-86ER45242	**California Institute of Technology, Pasadena**	
	12:25232	Progress in Materials Science 30 NO. 2. 81-134 (1986).
FG03-86ER52123	**California Univ., Los Angeles (USA). Dept. of Mechanical, Aerospace and Nuclear Engineering**	
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FG05-80ET53088	**Texas Univ., Austin (USA). Inst. for Fusion Studies**	
	12:26276	DOE/ET/53088—261
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	12:26278	DOE/ET/53088—271
FG05-84ER13191	**Texas Univ., Austin (USA). Dept. of Physics**	
	12:26073	DOE/ER/13191—7
FG05-84ER45104	**Florida Univ., Gainesville (USA). Dept. of Chemistry**	
	12:25280	DOE/ER/45104—3
FG05-84ER45115	**North Carolina State Univ., Raleigh (USA). Dept. of Materials Science and Engineering**	
	12:25255	DOE/ER/45115—3
FG05-85ER13362	**Florida Univ., Gainesville (USA)**	
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FG05-86ER13557	**Jackson State Univ., MS (USA). Dept. of Chemistry**	
	12:26074	DOE/ER/13557—1
FG05-86ER13604	**Texas Univ., Austin (USA). Dept. of Chemical Engineering**	
	12:25380	DOE/ER/13604—1
FG05-86ER13633	**North Carolina Univ., Chapel Hill (USA)**	
	12:25417	DOE/ER/13633—1
FG05-86ER45233	**Rice Univ., Houston, TX (USA). Dept. of Physics**	
	12:25699	DOE/ER/45233—1
FG05-86ER45259	**North Carolina State Univ., Raleigh (USA). Dept. of Chemistry**	
	12:25383	DOE/ER/45259—1
FG06-84ER60269	**Alaska Univ., Fairbanks (USA). Inst. of Marine Science**	
	12:25763	DOE/ER/60269—1
	12:25764	DOE/ER/60269—4
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FG08-84ER13234	**Desert Research Institute, Reno, NV**	
	12:25872	Photosynthesis Research 7 163-174 (1985).
FG09-84ER13296	**South Carolina Univ., Columbia (USA). Dept. of Chemistry**	
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FG09-84ER40160	**Georgia Univ., Athens (USA). Dept. of Physics**	
	12:26144	DOE/ER/40160—3
FG09-84SR14014	**Savannah State Coll., GA (USA). Dept. of Chemistry**	
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FG09-85ER60351	**Skidaway Inst. of Oceanography, Savannah, GA (USA)**	
	12:26018	DOE/ER/60351—2
FG22-83PC60036	**Purdue Univ., Lafayette, IN (USA). School of Chemical Engineering**	
	12:24399	DOE/PC/60036—14
FG22-83PC60786	**Lehigh Univ., Bethlehem, PA (USA). Center for Surface and Coatings Research**	
	12:25253	CONF-8609268—1
FG22-83PC60813	**Oklahoma State Univ., Stillwater (USA). School of Chemical Engineering**	
	12:24400	DOE/PC/60813—14
FG22-84PC70753	**Texas Southern Univ., Houston (USA). Dept. of Chemistry**	
	12:24403	DOE/PC/70753—T10
FG22-84PC70780	**Delaware Univ., Newark (USA). Center for Catalytic Science and Technology**	
	12:24404	DOE/PC/70780—T6
FG22-84PC70782	**Illinois Univ., Urbana (USA)**	
	12:24440	DOE/PC/70782—8
	12:25385	DOE/PC/70782—11
FG22-84PC70798	**Utah Univ., Salt Lake City (USA). Biomaterials Profiling Center**	
	12:24441	DOE/PC/70798—T6
FG22-84PC70801	**Illinois Univ., Urbana (USA). Dept. of Chemical Engineering**	
	12:24405	DOE/PC/70801—T10
FG22-84PC70804	**New York State Coll. of Ceramics, Alfred (USA)**	
	12:24435	CONF-860548—4
FG22-84PC70809	**University of Southern California, Los Angeles (USA)**	
	12:24406	DOE/PC/70809—T13
FG22-84PC70810	**SRI International, Menlo Park, CA (USA)**	
	12:24407	DOE/PC/70810—3
FG22-85PC80502	**Auburn Univ., AL (USA). Coal Conversion Lab.**	
	12:24409	DOE/PC/80502—T4
FG22-85PC80510	**Illinois Univ., Urbana (USA). Dept. of Chemistry**	
	12:24442	DOE/PC/80510—6
FG22-85PC80511	**Illinois Univ., Urbana (USA). Dept. of Mechanical and Industrial Engineering**	
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FG22-85PC80519	**New Mexico Univ., Albuquerque (USA). Powders and Granular Materials Lab.**	
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FG22-85PC80752	**Brigham Young Univ., Provo, UT (USA). Combustion Lab.**	
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FG22-86PC90502	**Alabama Univ., University (USA). Dept. of Chemistry**	
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FG22-86PC90504	**Auburn Univ., AL (USA). Coal Conversion Lab.**	
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FG22-86PC90507	**California Univ., Berkeley (USA). Coll. of Engineering**	
	12:24445	DOE/PC/90507—T2
FG22-86PC90515	**Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Chemical Engineering**	
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FG22-86PC90519	**New Mexico Univ., Albuquerque (USA). Dept. of Chemistry**	
	12:24446	DOE/PC/90519—T1
FG22-86PC90521	**North Dakota Univ., Grand Forks (USA). Dept. of Physics**	
	12:24447	DOE/PC/90521—T2
FG22-86PC90533	**Brigham Young Univ., Provo, UT (USA)**	
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FG22-86PC90578	**Princeton Univ., NJ (USA). Dept. of Chemical Engineering**	
	12:24476	DOE/PC/90578—1
FG22-86PC90909	**Colorado School of Mines, Golden (USA). Dept. of Chemical Engineering and Petroleum Refining**	
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FG22-86PC90959	**California Inst. of Tech., Pasadena (USA)**	
	12:24448	DOE/PC/90959—T1
FG22-86PC90960	**Massachusetts Inst. of Tech., Cambridge (USA)**	
	12:24449	DOE/PC/90960—3
FG79-83BP13837	**Lane Council of Governments, Eugene, OR (USA)**	
	12:24882	DOE/BP/13837—T1
FG79-83BP39220	**Confederated Salish and Kootenai Tribes, Pablo, MT (USA)**	
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NAS-7-100-956290	**Pennsylvania Univ., Philadelphia (USA). Moore School of Electrical Engineering**	
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W-31-109-ENG-38	**Argonne National Lab., IL (USA)**	
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W-7405-ENG-36	**Los Alamos National Lab., NM (USA)**	
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	Defense Advanced Research Projects Agency, Arlington, VA (USA). Information Science and Technology Office	
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	12:26382	LA-UR—87-1038
W-7405-ENG-48	**Lawrence Livermore National Lab., CA (USA)**	
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	Lawrence Livermore National Lab., CA (USA)	
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	Allied-Signal Corp., Charlotte, NC (USA). Synthetic Crystal Products	
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	BioSystems Analysis, Inc., Sausalito, CA (USA)	
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78	*See* SLAC-PUB-4244	E 1.99: DE87006785	MN -34D	12:26135
79	*See* SLAC-PUB-4243	DE87006784	MN -34D	12:26134
80	*See* SLAC-PUB-3972	DE87006583	MN -34D	12:26129
81	*See* SLAC-PUB-4245	DE87006786	MN -34D	12:26136
CONF-860722-	(ASME pressure vessel and piping conference and exhibit, Chicago, IL, USA, 20-24 Jul 1986)			
	American Society of Mechanical Engineers, 345 East 47 St., New York, NY 10017			12:24798
	American Society of Mechanical Engineers, 345 East 47 St., New York, NY 10017			12:24822
	American Society of Mechanical Engineers, 345 East 47 St., New York, NY 10017			12:25231
CONF-860736-	(SLAC summer institute on particle physics, Stanford, CA, USA, 29 Jul-9 Aug 1986)			
10	*See* SLAC-PUB-4223	E 1.99: DE87006779	MN -34D	12:26145
CONF-860758-	(13. international biometric conference, Seattle, WA, USA, 28-31 Jul 1986)			
2	*See* UCRL-94113	DE87008151	MN -32	12:26393
CONF-860788-	(2. workshop on hydrologic and geochemical monitoring of Long Valley caldera, Mammoth Lakes, CA, USA, 15-16 Jul 1986)			
Absts.	*See* LBL-22852	E 1.99: DE87007885	MN -11	12:24747
CONF-860810-	(Intersociety energy conversion engineering conference, San Diego, CA, USA, 25-29 Aug 1986)			
48	*See* N-87-15267			12:24727
CONF-860820-	(19. DOE/NRC nuclear air cleaning conference, Seattle, WA, USA, 17-21 Aug 1986)			
13	*See* BNL-NUREG-38549	TI87006914	MN -78	12:24831
CONF-860829-	(Annual joint meeting of the Electron Microscopy Society of America and the Microbeam Analysis Society, Albuquerque, NM, USA, 10-15 Aug 1986)			
41	*See* LBL-22879	E 1.99: DE87007616	MN -25	12:25193
CONF-860833-	(10. international conference on atomic physics, Tokyo, Japan, 25-29 Aug 1986)			
5	*See* DOE/ER/13596-3	E 1.99: DE87007917	MN -34A	12:26075
CONF-860853-	(10. international conference on Raman spectroscopy, Eugene, OR, USA, 31 Aug-5 Sep 1986)			
3	*See* LBL-22511	E 1.99: DE87003531	MN -4	12:25393
CONF-8608102-	(Compact synchrotron X-ray source design workshop, Upton, NY, USA, 25-27 Aug 1986)			
Summ.	*See* BNL-38789	E 1.99: DE87002155	MN -28	12:25643
CONF-8608149-	(International seminars on nuclear war international cooperation: the alternatives, Erice, Italy, 18-22 Aug 1986)			
1	*See* UCRL-95470	DE87000885	MN -41	12:26001

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CONF-8608153-	(International Metallographic Society conference on microstructural science, Boston, MA, USA, 3-7 Aug 1986)			
3	*See* MLM-3393(OP)	E 1.99: DE87000922	MN -25	12:25742
CONF-8608164-	(Microprogram on nonlinear diffusion equations and their equilibrium states, Berkeley, CA, USA, 25 Aug-13 Sep 1986)			
1	NTIS, PC A02; 3	DE87006966	MN -32	12:26376
CONF-860911-	(192. American Chemical Society national meeting, Anaheim, CA, USA, 7-12 Sep 1986)			
18-Rev.	*See* LBL-22089-Rev.	E 1.99: DE87006943	MN -4	12:25392
CONF-860913-	(International power sources symposium, Brighton, UK, 8-11 Sep 1986)			
3	*See* N-87-16445			12:24872
CONF-860932-	(Radiological accidents, perspectives and emergency planning preparedness, Bethesda, MD, USA, 15-17 Sep 1986)			
	NTIS, PC A16/MF A01; 1 (GPO Dep.)	E 1.99: DE87007690	MN -41	12:24832
CONF-860948-	(3. annual Pittsburgh coal conference, Pittsburgh, PA, USA, 8-12 Sep 1986)			
	MEMS, P.O. Box 270, Greensburg, PA 15601			12:24385
CONF-8609147-	(American Nuclear Society annual meeting, Bethesda, MD, USA, 15-17 Sep 1986)			
12	*See* BNL-NUREG-38549	TI87006914	MN -78	12:24831
CONF-8609203-	(International symposium on in-vivo body composition studies, Upton, NY, USA, 28 Sep-1 Oct 1986)			
Absts.	*See* BNL-39428	E 1.99: DE87006750	MN -48	12:25871
CONF-8609265-	(Clinical applications of cytometry, Charleston, SC, USA, 30 Sep-3 Oct 1986)			
1	*See* UCRL-96245	E 1.99: DE87007335	MN -48	12:25866
CONF-8609266-	(Japan Atomic Energy Research Institute conference, Naka, Japan, 29-30 Sep 1986)			
1-Vugraphs	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87005510	MN -20	12:26326
CONF-8609268-	(3. international symposium on particle size analysis and powder technology, Balatonfured, Hungary, 18 Sep 1986)			
1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008134	MN -25	12:25253
CONF-8609269-	(7. symposium on the physics and chemistry of ice, Grenoble, France, 1-5 Sep 1986)			
1	*See* UCRL-95941	DE87007334	MN -11	12:26016
CONF-861007-	(Nuclear science and nuclear power systems symposium, Washington, DC, USA, 29-31 Oct 1986)			
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 580-582(Feb 1987)			12:24815
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 571-575(Feb 1987)			12:24819
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 584-589(Feb 1987)			12:24827
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 576-579(Feb 1987)			12:24846
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 558-561(Feb 1987)			12:24847
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 102-109(Feb 1987)			12:25694
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 78-81(Feb 1987)			12:25704
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 85-90(Feb 1987)			12:25705
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 124-126(Feb 1987)			12:25706
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 386-388(Feb 1987)			12:25707
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 170-174(Feb 1987)			12:25708
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 261-265(Feb 1987)			12:25710
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 619-621(Feb 1987)			12:25711
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 396-400(Feb 1987)			12:25712
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 410-413(Feb 1987)			12:25713
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 616-618(Feb 1987)			12:25714
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 486-490(Feb 1987)			12:25715
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 499-503(Feb 1987)			12:25716
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 476-480(Feb 1987)			12:25717
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 481-485(Feb 1987)			12:25718
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 453-457(Feb 1987)			12:25719

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	IEEE Trans. Nucl. Sci., NS-34: No. 1, 427-430(Feb 1987)			12:25720
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 491-494(Feb 1987)			12:25722
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 590-594(Feb 1987)			12:25833
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 595-600(Feb 1987)			12:25834
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 601-605(Feb 1987)			12:25835
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 321-325(Feb 1987)			12:25908
	IEEE Trans. Nucl. Sci., NS-34: No. 1, 326-331(Feb 1987)			12:25909
CONF-861010-	(13. world energy conference, Cannes, France, 5-11 Oct 1986)			
23	*See* ESC-38	DE87751768	MN -95f	12:25139
CONF-8610115-	(4. international symposium on the production and neutralization of negative ions and beams, Upton, NY, USA, 27-31 Oct 1986)			
24	*See* BNL-39397	E 1.99: DE87006749	MN -34A	12:26067
CONF-8610122-	(8. international electric vehicle symposium, Washington, DC, USA, 20-23 Oct 1986)			
9	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87004819	MN -96	12:25173
CONF-8610138-	(1. annual energy research workshop on interlaboratory computing, Berkeley, CA, USA, 27-28 Oct 1986)			
Summs.	*See* LBL-22460	DE87007912	MN -32	12:26383
CONF-8610169-	(Department of Energy industrial heat pump workshop, Atlanta, GA, USA, 14-15 Oct 1986)			
	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007089	MN -95f	12:25128
CONF-8610178-	(TRADE conference, Las Vegas, NV, USA, 27-29 Oct 1986)			
	See ORAU-280	E 1.99: DE87007654	MN -41	12:26211
CONF-8610217-	(2. workshop on modelling of chemical reaction systems, Heidelberg, F.R. Germany, 1 Oct 1986, 1 Oct 1986)			
1	*See* LA-UR-86-4043	E 1.99: DE87003715	MN -4	12:25425
CONF-8610227-	(United Kingdom/United States conference on energy from landfill gas, Solihull, UK, 28-31 Oct 1986)			
1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87004836	MN -61E	12:24675
CONF-8610255-	(Computer and communications security conference, New York, NY, USA, 7-9 Oct 1986)			
1	*See* UCRL-95133	E 1.99: DE87006828	MN -32	12:26410
CONF-861106-	(IAEA international conference on plasma physics and controlled nuclear fusion research, Kyoto, Japan, 12-19 Nov 1986)			
24	*See* DOE/ET/51013-205	E 1.99: DE87007928	MN -20f	12:26274
CONF-861111-	(Conference on magnetism and magnetic materials, Baltimore, MD, USA, 17-21 Nov 1986)			
22	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87008026	MN -25	12:25249
23	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008027	MN -25	12:25250
CONF-861123-	(CEC/CEA international workshop on age-related factors in radionuclide metabolism and dosimetry, Angers, France, 26-28 Nov 1986)			
4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87004692	MN -48	12:25941
CONF-861158-	(8. North American International Association of Energy Economists conference: changing world energy economy, Cambridge, MA, USA, 19-21 Nov 1986)			
11	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006981	MN -11	12:25773
CONF-861185-	(Reduced Enrichment for Research and Test Reactors (RERTR) program international meeting, Gatlinburg, TN, USA, 3-6 Nov 1986)			
11	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006964	MN -83	12:24828
CONF-8611117-	(Annual meeting of the Society for Risk Analysis, Boston, MA, USA, 9-12 Nov 1986)			
5	*See* BNL-39576	E 1.99: DE87008456	MN -41	12:25960
CONF-8611121-	(Conference on chemical defense research, Aberdeen Proving Grounds, MD, USA, 15 Nov 1986, 15 Nov 1986)			
2	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87004075	MN -4	12:26212
CONF-8611123-	(Meeting on bone and renal failure, Antwerp, Belgium, 1 Nov 1986, 1 Nov 1986)			
1	*See* BNL-39108	DE87005388	MN -48	12:25870
CONF-8611146-	(Commission of European Communities symposium on CO/sub 2/ and other greenhouse: climate and associated impacts, Brussels, Belgium, 3-5 Nov 1986)			
1	*See* UCRL-95914	DE87006085	MN -11	12:25827
CONF-8611149-	(NASA/DOD control/structures interaction technology conference, Norfolk, VA, USA, 18-21 Nov 1986)			
	See N-87-16014			12:25439

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CONF-861204-	(4. Miami international symposium on multi-phase transport and particulate phenomena, Miami Beach, FL, USA, 15-17 Dec 1986)			
7	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006984	MN -64	12:25470
CONF-861207-	(Materials Research Society fall meeting, Boston, MA, USA, 1-5 Dec 1986)			
92	*See* LBL-21639	E 1.99: DE87007178	MN -70	12:24658
93	*See* SAND-86-1299C	A 1.99: DE87007390	MN -25	12:25204
94	*See* SAND-86-1169C	DE87007579	MN -25	12:25294
95	*See* LBL-22581	DE87007181	MN -25	12:25481
96	*See* SAND-86-1290C	E 1.99: DE87007846	MN -25	12:25295
CONF-861211-	(American Society of Mechanical Engineers winter meeting, Anaheim, CA, USA, 7-12 Dec 1986)			
18	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87000863	MN -90e	12:24480
CONF-861220-	(American Geophysical Union fall meeting, San Francisco, CA, USA, 8-12 Dec 1986)			
5	*See* LBL-23021	E 1.99: DE87007615	MN -11	12:26004
CONF-861230-	(13. symposium on explosives and pyrotechnics, Hilton Head Island, SC, USA, 2-4 Dec 1986)			
6	*See* MLM-3413(OP)	E 1.99: DE87004211	MN -45	12:25743
CONF-861240-	(3. national conference on high power microwave technology for defense applications, Albuquerque, NM, USA, 1-5 Dec 1986)			
15	*See* SAND-86-1785C	E 1.99: DE87003505	MN -25	12:25741
17	*See* LA-UR-86-3972	DE87003713	MN -20	12:26333
CONF-870101-	(American Society of Heating, Refrigerating, and Air-Conditioning Engineers meeting, New York, NY, USA, 18-21 Jan 1987)			
8	*See* LBL-21578	E 1.99: DE87007602	MN -95d	12:25103
CONF-870132-	(LASE-13: pulse power for lasers conference, Los Angeles, CA, USA, 11-16 Jan 1987)			
102	*See* UCRL-96256	E 1.99: DE87008213	MN -25	12:25304
CONF-870133-	(25. AIAA aerospace sciences meeting, Reno, NV, USA, 12-15 Jan 1987)			
5	*See* N-87-15441			12:25473
CONF-870136-	(12. workshop on geothermal reservoir engineering, Stanford, CA, USA, 20-22 Jan 1987)			
6	*See* LBL-23022	E 1.99: DE87007613	MN -66a	12:24749
7	*See* LBL-22987	E 1.99: DE87007614	MN -66a	12:24750
8	*See* LBL-23115	E 1.99: DE87008232	MN -66	12:24748
CONF-870152-	(Workshop on opportunities for atomic physics using slow highly-charged ions, Argonne, IL, USA, 12-13 Jan 1987)			
2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007660	MN -34A	12:26069
CONF-870154-	(15. international workshop on gross properties of nuclei and nuclear excitations, Hirschegg, Austria, 12-17 Jan 1987)			
3	*See* LA-UR-87-722	E 1.99: DE87007471	MN -34C	12:26192
CONF-870159-	(International conference on physics of chaos and systems far from equilibrium, Monterey, CA, USA, 11-14 Jan 1987)			
2	*See* LBL-23041	E 1.99: DE87008218	MN -25	12:25289
CONF-870167-	(Conference on physics and chemistry of semiconductor interfaces, Salt Lake City, UT, USA, 27-29 Jan 1987)			
1	*See* LBL-23016	E 1.99: DE87008217	MN -25	12:25288
CONF-870204-	(Society of Automotive Engineers international congress and expo, Detroit, MI, USA, 23-27 Feb 1987)			
2	*See* UCRL-95644	E 1.99: DE87003241	MN -96	12:25180
CONF-870213-	(6. American Society of Mechanical Engineers wind energy symposium, Dallas, TX, USA, 15-19 Feb 1987)			
1	*See* ECN-86-162		ND -60	12:24757
CONF-870247-	(International Rosenbluth symposium on dynamics of particles and plasmas, Austin, TX, USA, 2-5 Feb 1987)			
2	*See* GA-A-18719	E 1.99: DE87005832	MN -20g	12:26279
CONF-870249-	(Computing high energy physics, Pacific Grove, CA, USA, 2-6 Feb 1987)			
2	*See* FNAL/C-87/21	DE87006275	MN -34D	12:25645
3	*See* FNAL/C-87/22	E 1.99: DE87006415	MN -34D	12:26126
4	*See* LBL-22883	E 1.99: DE87006940	MN -34D	12:26128
CONF-870254-	(3. international conference on ultrastructure processing of ceramics, glasses, and composites, San Diego, CA, USA, 23-27 Feb 1987)			
3	*See* SAND-87-0402C	E 1.99: DE87007387	MN -4	12:25300
CONF-870260-	(International workshop hadron facility technology, Santa Fe, NM, USA, 2-5 Feb 1987)			
1	*See* BNL-39263	E 1.99: DE87006456	MN -28	12:25515
CONF-870267-	(US/Japan exchange (Q70) on next step machine design workshop, Livermore, CA, USA, 23-26 Feb 1987)			
1-Vugraphs	NTIS, PC A02; 3	DE87006629	MN -20	12:26271

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CONF-870270-	(Chemical processing table top seminar, Kingsport, TN, USA, 25 Feb 1987)			
1-Summ.	*See* FMPC-2078	E 1.99: DE87007311	MN -4	12:24622
CONF-870271-	(European AFCEA meeting, Brussels, Belgium, 16-20 Feb 1987)			
1	*See* LA-UR-87-805	E 1.99: DE87007501	MN -13	12:26379
CONF-870274-	(1. international seminar on electric power distribution, Sao Paulo, Brazil, 23-27 Feb 1987)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007671	MN -97b	12:24781
CONF-870275-	(ETR/INTOR meeting, Livermore, CA, USA, 12 Feb 1987)			
1-Vugraphs	NTIS, PC A02; 3	DE87007670	MN -20	12:26325
CONF-870302-	(Particle accelerator conference, Washington, DC, USA, 16-19 Mar 1987)			
7	*See* SAND-86-2254C	E 1.99: DE87006892	MN -28	12:25596
9	*See* SAND-86-2148C	E 1.99: DE87006699	MN -28	12:25519
10	*See* SAND-86-1998C	E 1.99: DE87006700	MN -28	12:25517
11	*See* SAND-86-1921C	E 1.99: DE87006698	MN -28	12:25647
12	*See* SAND-86-1999C	E 1.99: DE87006697	MN -28	12:25518
13	*See* BNL-39325	E 1.99: DE87006906	MN -28	12:25516
14	*See* LBL-22176	E 1.99: DE87006937	MN -28	12:25593
15	*See* SAND-86-2154C	DE87007026	MN -28	12:25594
16	*See* SAND-86-2155C	DE87007082	MN -28	12:25595
18	*See* UCRL-94926	DE87007092	MN -34A	12:26084
22	*See* LA-UR-87-890	DE87007486	MN -34A	12:26082
23	*See* LA-UR-87-896	E 1.99: DE87007485	MN -32	12:25592
35	*See* LA-UR-87-811	DE87007498	MN -32	12:26380
60	*See* LA-UR-87-798	DE87007502	MN -34A	12:26080
61	*See* LA-UR-87-810	DE87007499	MN -37	12:26081
86	*See* BNL-39452	E 1.99: DE87007633	MN -34A	12:26068
89	NTIS, PC A02; 3	DE87007927	MN -20	12:26272
CONF-870307-	(ASME/JSME/ISES solar energy conference, Honolulu, HI, USA, 22-27 Mar 1987)			
7	*See* SAND-86-1322C	E 1.99: DE87003503	MN -60	12:24762
9	*See* SERI/TP-217-3070	DE87001130	MN -60	12:24767
16	*See* SAND-86-1222C	E 1.99: DE87003096	MN -60	12:24761
CONF-870323-	(American Institute of Chemical Engineers spring national meeting, Houston, TX, USA, 29 Mar-2 Apr 1987)			
4	*See* UCRL-95924	E 1.99: DE87006427	MN -37	12:25363
CONF-870353-	(Annual SDI technical achievements symposium, Pacific Grove, CA, USA, 1-4 Mar 1987)			
2-Vugraphs	*See* SAND-87-0524C	E 1.99: DE87006901	MN -34A	12:26236
CONF-870354-	(IEEE international conference on robotics and automation, Raleigh, NC, USA, 30 Mar-2 Apr 1987)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87002814	MN -38	12:25433
CONF-870364-	(Energy from biomass and wastes, Orlando, FL, USA, 16-20 Mar 1987)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006608	MN -61A	12:24695
CONF-870376-	(Conference on inhalation toxicology: the design and interpretation of inhalation studies and their use in risk assessment, Hannover, F.R. Germany, 23-27 Mar 1987)			
1	NTIS, PC A03; 3	DE87005329	MN -48	12:25961
CONF-870385-	(SPIE conference on growth of compound semiconductors, Bay Point, FL, USA, 22-27 Mar 1987)			
4	*See* SAND-87-0386C	E 1.99: DE87006890	MN -37	12:25483
6	*See* SAND-87-0614C	DE87007388	MN -34A	12:26214
7	NTIS, PC A02; 3	DE87007659	MN -25	12:25276
CONF-870388-	(International conference on metallurgical coatings, San Diego, CA, USA, 23-27 Mar 1987)			
3	*See* SAND-87-0625C	E 1.99: DE87007392	MN -25	12:25484
4	*See* SAND-86-2444C	E 1.99: DE87007773	MN -21	12:26345
CONF-870394-	(Joint Army, Navy, NASA, Airforce propulsion systems hazards meeting, Huntsville, AL, USA, 17-19 Mar 1987)			
1	*See* UCRL-95555	DE87006820	MN -38	12:25752
2	*See* UCRL-95861	E 1.99: DE87007445	MN -4	12:25362
CONF-870396-	(Lunar and planetary science conference, Houston, TX, USA, 16-20 Mar 1987)			
1	*See* SAND-87-0139C	E 1.99: DE87006709	MN -25	12:25299
CONF-870398-	(Annual SDI technical achievements symposium, Washington, DC, USA, 1 Mar 1987)			
1-Summ.	*See* SAND-86-2366C	E 1.99: DE87003035	MN -38	12:25751
CONF-8703100-	(Defense Nuclear Agency workshop on the LD/sub 50/ for healthy young adults actively irradiated with low-let whole-body radiation, Arlington, VA, USA, 9-10 Mar 1987)			
1-Summ.	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007372	MN -48	12:25942
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007733	MN -41	12:25943
3-Vugraphs	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007374	MN -41	12:25944
CONF-8703102-	(Softool User's Group spring meeting, Santa Barbara, CA, USA, 30-31 Mar 1987)			
1	*See* LA-UR-87-1038	E 1.99: DE87007507	MN -32	12:26382

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CONF-8703106-	(DPG spring meeting of the nuclear physics sections, Groningen, Netherlands, 23-27 Mar 1987)			
	Verh. Dtsch. Phys. Ges., 22: No. 4, C-1.5(1987)			12:26194
CONF-870408-	(32. international SAMPE symposium and exhibition on advanced materials technology, San Diego, CA, USA, 6-9 Apr 1987)			
1	*See* N-87-16071			12:25293
CONF-870410-	(193. national meeting of the American Chemical Society, Denver, CO, USA, 5-10 Apr 1987)			
3	*See* SAND-86-2535C	E 1.99: DE87002489	MN -4	12:25399
5	*See* SAND-86-2591C	E 1.99: DE87002693	MN -4	12:25400
11	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87004271	MN -4	12:25338
14	*See* BNL-38959	E 1.99: DE87005262	MN -4	12:25371
16	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007367	MN -4	12:25339
CONF-870438-	(Spring meeting of the Materials Research Society, Anaheim, CA, USA, 21-25 Apr 1987)			
1	*See* SAND-86-2581C	E 1.99: DE87007678	MN -25	12:25298
2	*See* SAND-87-0832C	E 1.99: DE87007851	MN -25	12:25301
CONF-870477-	(Energy technology conference, Albuquerque, NM, USA, 15 Apr 1987, 15 Apr 1987)			
1	*See* SAND-87-0214C	DE87005524	MN -60	12:24764
CONF-870482-	(14. Department of Energy compatibility, aging and service life conference, Amarillo, TX, USA, 28-30 Apr 1987)			
2	*See* SAND-87-0336C	E 1.99: DE87005878	MN -38	12:25445
CONF-870484-	(Western states section/the Combustion Institute spring meeting, Provo, UT, USA, 6-7 Apr 1987)			
1	*See* UCRL-96163	E 1.99: DE87006377	MN -4	12:25401
2	*See* UCRL-96404	E 1.99: DE87007449	MN -4	12:25402
CONF-870490-	(International Atomic Energy Agency coordinated research project on isotope production for medical applications, Tokyo, Japan, 20-24 Apr 1987)			
1	*See* UCRL-95918	E 1.99: DE87007443	MN -34	12:26182
2	*See* UCRL-96368	E 1.99: DE87007451	MN -84	12:25906
CONF-870492-	(Nonlinear numerical methods and rational approximation conference, Antwerp, Belgium, 20-24 Apr 1987)			
1	*See* LA-UR-87-1036	E 1.99: DE87007508	MN -32	12:26381
CONF-870493-	(IUPAC symposium on pore structure characterization, Bad Soden, F.R. Germany, 26-29 Apr 1987)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008022	MN -90a	12:24436
CONF-870495-	(Conference on better ceramics through chemistry, Palo Alto, CA, USA, 15-19 Apr 1987)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007664	MN -25	12:25251
CONF-870502-	(5. symposium on coastal and ocean management, Seattle, WA, USA, 26-29 May 1987)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006631	MN -11	12:25850
CONF-870505-	(32. international gas turbine conference and exhibition, Anaheim, CA, USA, 31 May-4 Jun 1987)			
3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006996	MN -25	12:25252
CONF-870510-	(Annual meeting of the American Society of Lubrication Engineers, Anaheim, CA, USA, 11-14 May 1987)			
1	*See* SAND-86-1849C	E 1.99: DE87001423	MN -25	12:25205
CONF-870513-	(171. Electrochemical Society meeting, Philadelphia, PA, USA, 10-15 May 1987)			
3	*See* SAND-86-2714C	E 1.99: DE87003516	MN -4	12:25206
CONF-870516-	(5. international symposium on gaseous dielectrics, Knoxville, TN, USA, 3-7 May 1987)			
1	NTIS, PC A02; 3	DE87006623	MN -34A	12:26070
2	NTIS, PC A02; 3	DE87006624	MN -34A	12:25723
3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007673	MN -48	12:25962
4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007672	MN -48	12:25963
CONF-870519-	(9. annual meeting of the European Safeguards Research and Development Association: safeguards and nuclear material management, London, UK, 12-14 May 1987)			
1	*See* LA-UR-87-962	DE87007454	MN -15	12:24670
CONF-870523-	(9. symposium on biotechnology for fuels and chemicals, Boulder, CO, USA, 5-8 May 1987)			
Absts.	*See* ORNL/M-326	E 1.99: DE87007692	MN -61	12:24705
CONF-870529-	(Society of Petroleum Engineers meeting on low permeability reservoirs, Denver, CO, USA, 18-20 May 1987)			
1	*See* SAND-86-2382C	E 1.99: DE87006896	MN -11	12:26015
2	*See* SAND-86-2412C	E 1.99: DE87007433	MN -92a	12:24557
CONF-870533-	(11. Canadian congress of applied mechanics, Edmonton, Canada, 31 May-4 Jun 1987)			
1	*See* SAND-86-2281C	E 1.99: DE87000453	MN -34	12:26117
2	*See* SAND-86-2169C	E 1.99: DE87000960	MN -25	12:25296
3	*See* SAND-86-2347C	E 1.99: DE87000984	MN -25	12:25297
CONF-870538-	(34. international technical communication conference, Denver, CO, USA, 10-13 May 1987)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87000883	MN -13	12:26408

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4	*See* UCRL-96188	DE87006466	MN -32	12:26394
CONF-870565-	(Department of Energy computer security group conference, Albuquerque, NM, USA, 5-7 May 1987)			
1	*See* SAND-86-2543C	E 1.99: DE87005527	MN -32	12:26386
CONF-870567-	(2. international conference on supercomputing, San Francisco, CA, USA, 1 May 1987, 1 May 1987)			
1	*See* DOE/ER/25009-391	E 1.99: DE87005029	MN -32	12:26377
CONF-870574-	(Computing conference, Anaheim, CA, USA, 1 May 1987)			
1	*See* SAND-87-0516C	DE87006707	MN -32	12:26390
2	*See* SAND-87-0587C	E 1.99: DE87006895	MN -32	12:26391
CONF-870576-	(IGARSS '87, Ann Arbor, MI, USA, 18-21 May 1987)			
2	*See* LA-UR-87-571	DE87006059	MN -11	12:25768
CONF-870577-	(International symposium on acidification and water pathways, Bolkesjo, Norway, 4-8 May 1987)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006630	MN -11	12:25851
CONF-870581-	(Symposium on glass and ceramics for nuclear repositories, Madrid, Spain, 21-22 May 1987)			
1	*See* LBL-22871	E 1.99: DE87006939	MN -70	12:25287
CONF-870583-	(International symposium on optical particle sizing: theory and practice, Rouen, France, 12-15 May 1987)			
1	*See* BNL-39424	E 1.99: DE87006748	MN -4	12:25337
CONF-870584-	(Technical symposium southeast on optics, electro-optics and sensors, Orlando, FL, USA, 17-22 May 1987)			
1	NTIS, PC A02; 3	DE87006632	MN -95d	12:24968
CONF-870586-	(International conference on resource mobilization for drinking water supply and sanitation in developing nations, San Juan, Puerto Rico, 26-29 May 1987)			
1	*See* UCRL-94614	E 1.99: DE87007332	MN -11	12:24889
CONF-870588-	(20. annual scanning electron microscopy conference, Hamilton, Canada, 3-8 May 1987)			
1-Draft	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007658	MN -25	12:25277
CONF-870746-	(International conference on tribology, London, UK, 1-3 Jul 1987)			
1	*See* N-87-15305			12:25263
CONF-870854-	(17. international congress of refrigeration, Vienna, Austria, 24-29 Aug 1987)			
1	*See* N-87-15442			12:25438
CONF-871030-	(Coal science international conference, Maastricht, Netherlands, 26-30 Oct 1987)			
1	*See* ECN-87-002		ND -90e	12:24486
DFVLR-FB-				
85-36	*See* ESA-TT-61			12:24734
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86/ 2	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE86000295	STD -92a	12:24513
DOE/BC/10525-				
16	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE87001232	STD -92b	12:24601
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747	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE87006832	MN -78	12:24800
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T34-Vol.2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007869	MN -61F	12:24696
T35	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE87007871	MN -61	12:24697
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T39	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE87007874	MN -61F	12:24686
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T1	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007596	MN -70	12:24612
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3	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87007593	MN -70	12:24615
4	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007594	MN -70	12:24616
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4	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007590	MN -48	12:25919
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9	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE87005233	MN -61E	12:24699
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1	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007936	MN -21	12:26327
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37	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99: DE87005920	MN -21	12:26328
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0320	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007687	MN -11	12:25845
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0173(86)	NTIS, PC A04/MF A01 - GPO; 1 (GPO Dep.)	E 1.99: DE87006840	MN -98	12:24891
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0192/ 2	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87005219	MN -13	12:24892
0304	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87008005	MN -13	12:26364
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9	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007320	MN -34A	12:26072
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3	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87006411	MN -4	12:25435
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1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006422	MN -4	12:25379
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3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007917	MN -34A	12:26075
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391	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87005029	MN -32	12:26377
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3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006732	MN -34D	12:26144
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2	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87008021	MN -25	12:25279
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3	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007107	MN -25	12:25254
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5	NTIS, PC A02; 3	DE87006811	MN -4	12:25381
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266	NTIS, PC A03/MF AO1; 1 (GPO Dep.)	E 1.99: DE87007585	MN -21	12:26277
271	Institute for Fusion Studies, Univ. of Texas, Austin, TX 78712	TI87007386	ND -20	12:26278
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DOE/EV/10374-					
6	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE87007769	MN -11	12:25830
DOE/FE-					
0080	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007726	MN -92	12:24527
DOE/FE/60177-					
2299	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007389	MN -91	12:24603
2300	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007915	STD -91	12:24597
2303	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE87008056	MN -91	12:24604
2305-Vol.2	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE87008496	STD -90c	12:24394
2307	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE87008437	MN -91	12:24602
2308	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE87008443	STD -90c	12:24395
DOE/FE/60181-					
115	NTIS, PC A02/MF A01; 1		DE87008020	MN -90i	12:24456
DOE/FE/60740-					
T1	Pergamon Journals Limited, Headington Hill Hall, Oxford OX3 OBW, UK		TI87007749	ND -90	12:24386
DOE/IG-					
0235	USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830		TI87007820	STD -92	12:24546
DOE/JPL-					
1060-89	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE87005428	MN -62	12:24729
7004490	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE87004490	MN -63b	12:24701
7006117	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99:	DE87006117	MN -63b	12:24702
DOE/LC/11086-					
2296	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE87008080	MN -91	12:24598
DOE/MC/21108-					
2191	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE87000621	MN -90i	12:24457
DOE/MC/21181-					
1950-Vol.7	NTIS, PC A09/MF A01; 1 (GPO Dep.)	E 1.99:	DE86006637	MN -92a	12:24542
DOE/MC/22059-					
2306	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE87007856	MN -90c	12:24396
DOE/METC-					
86/ 0243	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86006589	STD -90c	12:24397
87/ 0249	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE87001030	STD -92a	12:24543
87/ 0250	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE87001031	STD -92a	12:24544
87/ 0251	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE87001032	STD -92a	12:24470
DOE/NASA-					
0006-3	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE87006958	STD -60	12:24756
DOE/NBM-					
7007268	NTIS, PC A08; 3		DE87007268	MN -95e	12:25160
7007410	NTIS, PC A04; 3		DE87007410	MN -95d	12:25095
7007411	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007411	MN -95	12:25096
7007676	NTIS, PC A02/MF A01; 1 (GPO Dep.)	A 1.99:	DE87007676	MN -97	12:25131
7007677	NTIS, PC A02/MF A01; 1 (GPO Dep.)	A 1.99:	DE87007677	MN -97	12:25132
DOE/NE/44352-					
T2	NTIS, PC A09/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007754	MN -70	12:24617
DOE/NE/44507-					
3	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE87008362	MN -11	12:24618
DOE/NV/10308-					
H1-Vol.1	NTIS, PC A99/MF A01; 1 (GPO Dep.)	E 1.99:	DE87008354	STD -97c	12:25174
DOE/NV/10322-					
10	NTIS PC E15/MF $25.15; 1 (GPO Dep.)	E 1.99:	DE87007583	MN -70	12:26002
12	NTIS PC E04/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007777	MN -70	12:24619
13	NTIS PC E06/MF $10.35; 1 (GPO Dep.)	E 1.99:	DE87007778	MN -70	12:24620
DOE/NV/10336-					
1	NTIS, PC A13; 3		DE87007756	MN -96	12:25175
DOE/NV/10354-					
T1	NTIS, PC A03; 3		DE87006798	MN -4	12:25384
DOE/NV/10511-					
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE87001696	MN -20	12:26330
DOE/OR/00033-					
T293	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007655	MN -13	12:26366
DOE/PC/42302-					
T5	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE87006831	STD -90b	12:24387
DOE/PC/50031-					
T5	NTIS, PC A07/MF A01 (GPO Dep.)	E 1.99:	DE87006449	STD -90d	12:24398
DOE/PC/60036-					
14	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007383	MN -90a	12:24399
DOE/PC/60813-					
14	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE87006802	MN -90d	12:24400
DOE/PC/70018-					
34	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE87007857	MN -90d	12:24401
DOE/PC/70030-					
T7	NTIS, PC A11; 3		DE87006115	MN -90d	12:24402
DOE/PC/70753-					
T10	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE87007402	MN -90a	12:24403
DOE/PC/70771-					
T5	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE87006703	MN -90e	12:24458
DOE/PC/70780-					
T6	NTIS, PC A03; 3		DE87007384	MN -90a	12:24404

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DOE/PC/70782-				
8	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008374	MN -90a	12:24440
11	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008390	MN -90a	12:25385
DOE/PC/70798-				
T6	NTIS, PC A03/MF A01; 1	DE86015845	MN -90a	12:24441
DOE/PC/70801-				
T10	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87008186	MN -90d	12:24405
DOE/PC/70809-				
T13	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007684	MN -90	12:24406
DOE/PC/70810-				
3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007115	MN -90d	12:24407
DOE/PC/70815-				
T8	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007839	MN -90e	12:24482
DOE/PC/71504-				
7	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE87008391	MN -90e	12:24483
DOE/PC/80015-				
6	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87008302	MN -90d	12:24408
DOE/PC/80502-				
T4	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87006667	MN -90a	12:24409
DOE/PC/80510-				
6	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008185	MN -90d	12:24442
DOE/PC/80752-				
T7	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87006399	MN -90e	12:24484
DOE/PC/81008-				
T7	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007682	MN -90i	12:25779
DOE/PC/81210-				
T14	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008057	MN -90b	12:24388
DOE/PC/81520-				
T1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87003180	STD -90c	12:24485
DOE/PC/90009-				
1	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87006665	MN -90d	12:25386
DOE/PC/90502-				
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87008001	MN -90a	12:24443
DOE/PC/90504-				
T2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007536	MN -90a	12:24444
DOE/PC/90507-				
T2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008055	MN -90b	12:24445
DOE/PC/90515-				
T1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008053	MN -90a	12:25344
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T1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87006751	MN -90a	12:24446
DOE/PC/90521-				
T2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008300	MN -90a	12:24447
DOE/PC/90533-				
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87008433	MN -90d	12:24410
DOE/PC/90578-				
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007398	MN -90a	12:24476
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T2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006408	MN -90d	12:24411
DOE/PC/90959-				
T1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007400	MN -90	12:24448
DOE/PC/90960-				
3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008417	MN -90b	12:24449
DOE/PE/77035-				
T1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87006072	MN -98B	12:24528
T2	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006038	MN -98B	12:24910
T3	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87006123	MN -98B	12:24911
T4	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87006212	MN -98B	12:24912
T5	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87006213	MN -98B	12:24913
T6	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006238	MN -98B	12:24914
T7	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87006605	MN -98B	12:24915
T8	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87004970	MN -98B	12:24916
DOE/RA/50150-				
23	NTIS, PC A02; 3	DE87008018	MN -97	12:24784
DOE/RA/50307-				
T1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008110	MN -95e	12:24688
DOE/RA/50659-				
T1	NTIS, PC A09; 3	DE87007755	MN -97c	12:24768
DOE/S-				
0055	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87006193	MN -20	12:26269
DOE/SR/14014-				
3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007878	MN -4	12:25387
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7007921	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87007921	MN -70	12:24657
DP-				
1723	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007832	STD -4	12:25345
1736	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007888	STD -4	12:24609
DPST-				
87-203	NTIS, PC A14; 3	DE87007515	MN -4	12:24674
DTNSRDC/SME-				
86/ 52	*See* AD-A-176137/8/XAB			12:25247
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2904	*See* N-87-16321			12:25440

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2992	*See* N-87-16445			12:24872
3073	*See* N-87-15267			12:24727
3325	*See* N-87-16113			12:25264
3326	*See* N-87-15305			12:25263
3348	*See* N-87-15442			12:25438
3356	*See* N-87-15441			12:25473
3366	*See* N-87-16065			12:25504
3390	*See* N-87-16071			12:25293
ECN-				
86-162	ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		ND -60	12:24757
86-164	ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		ND -60	12:24758
86-176	ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		ND -11	12:25780
87-002	ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		ND -90e	12:24486
87-010	ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		ND -60	12:24759
ECRC/M-				
2083	Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK		ND -95d	12:25097
2104	Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK		ND -95e	12:25161
2107	Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK		ND -95d	12:25098
2108	Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK		ND -48	12:25099
ECRC/R-				
2112	Electricity Council Research Centre, Capenhurst, Chester CH1 6ES, UK		ND -97a	12:24785
ED-				
91/ 54	NTIS (US Sales Only), PC A02/MF A01; 1	DE87751844	MN -95f	12:25133
92/ 138	NTIS (US Sales Only), PC A02/MF A01; 1	DE87751845	MN -95d	12:25100
97/ 175	NTIS (US Sales Only), PC A03/MF A01; 1	DE87751842	MN -95f	12:25134
102/ 81	NTIS (US Sales Only), PC A02/MF A01; 1	DE87751843	MN -95f	12:25135
EFI-TR-				
3166	NTIS (US Sales Only), MF A01; 2	DE87751701	MN -97e	12:24690
EGG-				
2464	*See* NUREG/CR-4696	TI87007118	MN -78	12:24843
2481	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE87006196	STD -20e	12:26331
10282-2144	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007865	MN -92a	12:24530
10282-2149	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008052	MN -11	12:25846
EH-				
9	*See* PB-87-142626/XAB			12:25999
EPA-				
600/ 3-87/ 004	*See* PB-87-145306/XAB			12:25805
600/ 4-87/ 003	*See* PB-87-145447/XAB			12:25808
600/ 8-83/ 028AF	*See* PB-87-142386/XAB			12:25793
600/ 8-83/ 028BF	*See* PB-87-142394/XAB			12:25794
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600/ 8-84/ 020CF	*See* PB-87-142972/XAB			12:25800
600/ 8-84/ 020DF	*See* PB-87-142980/XAB			12:25801
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600/ D-87/ 018	*See* PB-87-146247/XAB			12:25819
600/ D-87/ 019	*See* PB-87-146254/XAB			12:25820
600/ D-87/ 020	*See* PB-87-146262/XAB			12:25983
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600/ D-87/ 040	*See* PB-87-147096/XAB			12:25984
600/ J-85/ 458	*See* PB-87-145603/XAB			12:25842
600/ J-86/ 190	*See* PB-87-145512/XAB			12:26000
EPRI-AP-				
4794	NTIS, PC A04/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1 (GPO Dep.)	E 1.99: DE87004104	MN -60	12:24752
5098-SR	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920317	ND -93	12:24770
5101	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920341	ND -90d	12:24412
5111	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920345	ND -66b	12:24751
5119	NTIS, PC A03/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1 (GPO Dep.)	E 1.99: DE87008008	MN -90c	12:25388
EPRI-CS-				
4781	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920358	ND -90	12:24771
4840	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920318	ND -90	12:24772
5055	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920319	ND -90i	12:24775

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5104	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920355	ND -90g	12:24773
EPRI-EA-				
5091-Vol.2	Research Reports Center, Box 50490, Palo Alto, CA 94303; 3	TI87920283	ND -11	12:25767
EPRI-EL-				
4935	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920352	ND -97a	12:24786
4957	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920321	ND -97	12:25162
5063-Vol.1	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920322	ND -97a	12:24787
5090	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920339	ND -97a	12:24788
EPRI-EM-				
4571	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920323	ND -95f	12:25136
4949	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920340	ND -95f	12:25137
4961	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920336	ND -97	12:24936
4962	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920337	ND -97	12:24937
5083	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920325	ND -95	12:25138
5110	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920360	ND -97a	12:24789
5113-Vol.2	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920326	ND -95d	12:25101
5114	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920354	ND -97b	12:24938
EPRI-NP-				
4848	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920298	ND -28	12:25477
4970	NTIS, PC A05/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1 (GPO Dep.)	E 1.99: DE87006955	MN -78	12:24794
5010	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920300	ND -78	12:24834
5025	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920246	ND -41	12:24835
5057	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920307	ND -38	12:24817
5064-M	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920308	ND -78	12:24795
5077	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920343	ND -70B	12:24621
5081	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920311	ND -78	12:24825
5086	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920312	ND -38	12:25478
EPRI-P-				
5087	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI87920327	ND -13	12:24939
ERA-				
83-0096	*See* ERATL-87/01/XAB			12:24522
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87/ 01/ XAB	NTISPC $139.00			12:24522
ESA-CR(P)-				
262	NTIS, PC A04/MF A01			12:25191
2236	*See* ESA-ESTL-7			12:25428
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7	NTIS, PC A02/MF A01			12:25428
ESA-TT-				
61	NTIS, PC A03/MF A01; original German version avail. at DFVLR, Cologne, West Germany DM 15			12:24734
ESC-				
38	NTIS (US Sales Only), PC A04/MF A01; 1	DE87751768	MN -95f	12:25139
39	NTIS (US Sales Only), PC A06/MF A01; 1	DE87751769	MN -98F	12:24879
ESC-WR-				
86-21	Energie Studie Centrum ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		ND -95f	12:25140
86-22	Energie Studie Centrum ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		ND -13	12:24501
86-23	Energie Studie Centrum ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		ND -80	12:24806
ETN-				
86-98114	*See* ESA-ESTL-7			12:25428
86-98147	*See* ESA-CR(P)-262			12:25191
86-98246	*See* ESA-TT-61			12:24734
86-98374	*See* RAE-TR-5066			12:25202
FCR-				
7888A	*See* AD-A-176066/9/XAB			12:24959
FMPC-				
2078	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007311	MN -4	12:24622

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FNAL/C-				
87/ 21	NTIS, PC A02; 3	DE87006275	MN -34D	12:25645
87/ 22	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006415	MN -34D	12:26126
FNAL/Pub-				
87/ 25-A	NTIS, PC A03; 3	DE87007046	MN -34D	12:26165
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19135-2	*See* N-87-15272			12:25472
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18719	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE87005832	MN -20g	12:26279
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86/ E/ 44	NTIS (US Sales Only), PC A08/MF A01; 1	DE87751727	MN -11	12:25781
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3299-FP	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87004343	MN -80	12:26378
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34	NTIS (US Sales Only), PC A03/MF A01; 1	TI87900593	STD -90e	12:24487
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86-1100	Divisie Onderzoek en Ontwikkeling KEMA, P.O. Box 9035, 8600 ET Arnhem, Netherlands		ND -90i	12:24450
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10884-MS	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007711	STD -25	12:25452
10908-MS	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE87007724	STD -20d	12:26332
10937-T	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99: DE87007721	STD -34D	12:26127
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87-5	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007760	MN -34A	12:26093
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87-805	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007501	MN -13	12:26379
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87-811	NTIS, PC A02; 3	DE87007498	MN -32	12:26380
87-890	NTIS, PC A02; 3	DE87007486	MN -34A	12:26082
87-896	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007485	MN -32	12:25592
87-962	NTIS, PC A02; 3	DE87007454	MN -15	12:24670
87-1036	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007508	MN -32	12:26381
87-1038	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007507	MN -32	12:26382
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19515	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007910	MN -11	12:26013
19516	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99: DE87007911	MN -11	12:26014
20210	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87003549	MN -41	12:25831
21187	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007907	STD -95d	12:25102
21330	NTIS, PC A02; 3	DE87007179	MN -92b	12:24540
21345-Rev.	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006144	MN -20	12:26334
21557	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007603	MN -41	12:25832
21578	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007602	MN -95d	12:25103
21639	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007178	MN -70	12:24658
21662	NTIS, PC A02; 3	DE87006148	MN -4	12:25390
21859	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007906	STD -11	12:25391
22058	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99: DE87008237	MN -48	12:25863
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22353	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007897	STD -94c	12:25260
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22581	NTIS, PC A02; 3	DE87007181	MN -25	12:25481
22641	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007887	MN -70	12:26003
22650	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE87008226	MN -25	12:25192
22682	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007891	STD -90d	12:24413
22705	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87007607	MN -94cc	12:24871
22753	NTIS, PC A06; 3	DE87007600	MN -25	12:25261
22852	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87007885	MN -11	12:24747
22871	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87006939	MN -70	12:25287
22872	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE87007898	STD -95d	12:25106
22879	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007616	MN -25	12:25193
22883	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006940	MN -34D	12:26128
22936	NTIS, PC A09/MF A01; 1 (GPO Dep.)	E 1.99: DE87008216	MN -25	12:25346
22987	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007614	MN -66a	12:24750
23016	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008217	MN -25	12:25288
23021	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007615	MN -11	12:26004
23022	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007613	MN -66a	12:24749
23041	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87008218	MN -25	12:25289
23069	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99: DE87007903	STD -70	12:26005
23115	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008232	MN -66	12:24748
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3393(OP)	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87000922	MN -25	12:25742
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88824	*See* N-87-15267			12:24727
88902	*See* N-87-15305			12:25263
88919	*See* N-87-15442			12:25438
88923	*See* N-87-15441			12:25473
88927	*See* N-87-16113			12:25264
88942	*See* N-87-16071			12:25293
89054	*See* N-87-15782			12:26207
89055	*See* N-87-16510			12:25947
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2625	*See* N-87-13022			12:25783
2639	*See* N-87-12680			12:25292
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1231	*See* PB-87-151049/XAB			12:24829
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7900580	National Wetlands Research Center, US Fish & Wildlife Service, 1010 Gause Blvd., Slidell, LA 70458	TI87900580	MN -11	12:25848
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87-1	New York State Energy Research and Development Authority, Two Rockefeller Plaza, Albany, NY 12223	TI87900587	MN -95f	12:25141

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86/ 0116	*See* PB-87-144143/XAB			12:24532
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325	*See* DOE/EA-0257	E 1.99: DE87007730	MN -34A	12:26181
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86/ 2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007696	MN -25	12:25184
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87-147443/ XAB	NTIS, PC A05/MF A01			12:24678
87-147450/ XAB	NTIS, PC A05/MF A01			12:24418
87-147468/ XAB	NTIS, PC A08/MF A01			12:24419
87-147476/ XAB	NTIS, PC A02/MF A01			12:24960
87-147484/ XAB	NTIS, PC A04/MF A01			12:24556
87-148706/ XAB	NTIS, PC A07/MF A01			12:25361
87-149365/ XAB	NTIS, PC A08/MF A01			12:24550
87-150868/ XAB	NTIS, PC A06/MF A01			12:24551
87-151049/ XAB	NTIS, PC A08/MF A01			12:24829
87-152336/ XAB	NTIS, PC A04/MF A01			12:25826
87-153888/ XAB	NTIS, PC A09/MF A01			12:24552
87-153896/ XAB	NTIS, PC A09/MF A01			12:24679
87-153904/ XAB	NTIS, PC A06/MF A01			12:24559
87-153912/ XAB	NTIS, PC A04/MF A01			12:24596
87-153920/ XAB	NTIS, PC A05/MF A01			12:25118
87-153953/ XAB	NTIS, PC A05/MF A01			12:25265
87-153961/ XAB	NTIS, PC A05/MF A01			12:25172
87-153979/ XAB	NTIS, PC A04/MF A01			12:24592
87-153987/ XAB	NTIS, PC A05/MF A01			12:24593
87-153995/ XAB	NTIS, PC A08/MF A01			12:24594
87-154001/ XAB	NTIS, PC A06/MF A01			12:24553
87-154019/ XAB	NTIS, PC A03/MF A01			12:25143
87-154860/ XAB	NTIS, PC A04/MF A01			12:24554
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PFC/CP-				
86-19	*See* DOE/ET/51013-205	E 1.99: DE87007928	MN -20f	12:26274
PNL-				
6073	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87007908	MN -70	12:24626
6079	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87006738	MN -95d	12:25119
6105	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE87004634	MN -60	12:24753
6125	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE87007896	MN -41	12:25950
6128-Vol.1	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99: DE87007161	MN -62	12:24730
6143	NTIS, PC A12/MF A01; 1 (GPO Dep.)	E 1.99: DE87008351	MN -95f	12:25479
6159	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE87007902	MN -90d	12:24452
6174	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007894	MN -70	12:24627
6185	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007949	MN -48	12:25985
PNL-SA-				
14385	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87002065	MN -34B	12:26039
PNL/SRP-				
6146	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007842	MN -70	12:24628

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PPG-				
1021	*See* DOE/ER/52123-1	E 1.99: DE87007965	MN -20	12:26329
PPPL-				
2408	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008065	STD -20f	12:26285
2409	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008066	STD -20a	12:26343
2410	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87008073	STD -20f	12:26286
2411	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008072	STD -20f	12:26287
2412	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008071	STD -20g	12:26288
2413	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008064	STD -20g	12:26289
2414	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008068	STD -20a	12:26290
2415	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008067	STD -20a	12:26291
2416	NTIS, PC A03/MF 01; 1 (GPO Dep.)	E 1.99: DE87008074	STD -20g	12:26292
2417	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008069	STD -20f	12:26344
2418	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008070	STD -20g	12:26293
2423	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007976	STD -20g	12:26294
PSB-IoEE-TM-				
97	British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 7BQ		ND -95d	12:25120
R-				
83-915540-27	*See* N-87-11858			12:25501
RAD-				
86-218-043-11	*See* PB-87-147484/XAB			12:24556
RAE-MAT/STRUCT-				
136	*See* RAE-TR-5066			12:25202
RAE-TR-				
5066	NTIS, PC A02/MF A01			12:25202
REG/G-				
3.1-Rev.2	Nuclear Regulatory Commission Washington, DC 20555	TI87900577	MN -16	12:25444
REPT-				
86-720-128	*See* PB-87-150868/XAB			12:24551
681104	*See* N-87-11837			12:24955
RFP-Trans-				
466	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87008182	MN -25	12:25487
RISO-M-				
2582	NTIS (US Sales Only), PC A03/MF A01	DE87751684	MN -60	12:24760
2609	NTIS (US Sales Only), MF A01; 2	DE87751683	MN -94d	12:24864
RISO-R-				
233	NTIS (US Sales Only), PC A15/MF A01; 1	DE87751685	MN -11	12:25769
RP-				
49	*See* PB-87-142204/XAB			12:24555
RU-				
87/ B1/ 189	*See* FNAL/Pub-87/25-A	DE87007046	MN -34D	12:26165
S-				
163	*See* PB-87-140653/XAB			12:25998
SAND-				
84-0383	*See* NUREG/CR-3468	TI87007078	MN -78	12:24841
85-2604	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE87007946	MN -92	12:26011
86-0594	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007823	MN -32	12:25203
86-0981	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007432	MN -62	12:24731
86-1122	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007826	MN -70	12:26006
86-1169C	NTIS, PC A02; 3	DE87007579	MN -25	12:25294
86-1222C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87003096	MN -60	12:24761
86-1290C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007846	MN -25	12:25295
86-1299C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	A 1.99: DE87007390	MN -25	12:25204
86-1322C	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87003503	MN -60	12:24762
86-1623	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87004777	MN -60	12:24763
86-1785C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87003505	MN -25	12:25741
86-1832	*See* NUREG/CR-4713	TI87006736	MN -78	12:24844
86-1849C	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87001423	MN -25	12:25205
86-1921C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006698	MN -28	12:25647
86-1998C	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006700	MN -28	12:25517
86-1999C	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006697	MN -28	12:25518
86-2024C	NTIS, PC A02; 3	DE87007083	MN -70	12:24629
86-2084-Vol.3	*See* NUREG/CR-4550-Vol.3	TI87007079	MN -78	12:24842
86-2106	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87004778	MN -80	12:24814
86-2137	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007822	MN -70	12:26019
86-2148C	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006699	MN -28	12:25519
86-2154C	NTIS, PC A02; 3	DE87007026	MN -28	12:25594
86-2155C	NTIS, PC A02; 3	DE87007082	MN -28	12:25595
86-2169C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87000960	MN -25	12:25296
86-2175	*See* NUREG/CR-4742	TI87006737	MN -78	12:24845
86-2254C	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006892	MN -28	12:25596
86-2281C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87000453	MN -34	12:26117
86-2347C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87000984	MN -25	12:25297
86-2366C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87003035	MN -38	12:25751
86-2382C	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87006896	MN -11	12:26015
86-2412C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007433	MN -92a	12:24557
86-2444C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007773	MN -21	12:26345
86-2535C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87002489	MN -4	12:25399
86-2543C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87005527	MN -32	12:26386
86-2564	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008079	MN -32	12:25431
86-2581C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007678	MN -25	12:25298
86-2591C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87002693	MN -4	12:25400

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86-2673	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007950	MN -70	12:24630
86-2714C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87003516	MN -4	12:25206
86-2917	NTIS, PC A04; 3	DE87007434	MN -32	12:26387
87-0011	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE87007347	MN -34	12:26235
87-0072	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87007953	MN -34A	12:25728
87-0139C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87006709	MN -25	12:25299
87-0206	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007947	STD -32	12:26388
87-0214C	NTIS, PC A02; 3	DE87005524	MN -60	12:24764
87-0336C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87005878	MN -38	12:25445
87-0354	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007825	MN -25	12:25482
87-0369	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007824	MN -32	12:26389
87-0386C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006890	MN -37	12:25483
87-0402C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007387	MN -4	12:25300
87-0516C	NTIS, PC A02; 3	DE87006707	MN -32	12:26390
87-0524C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006901	MN -34A	12:26236
87-0587C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006895	MN -32	12:26391
87-0614C	NTIS, PC A02; 3	DE87007388	MN -34A	12:26214
87-0625C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007392	MN -25	12:25484
87-0832C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007851	MN -25	12:25301
87-8208	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008347	MN -25	12:25207
87-8213	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87008345	MN -93	12:25427
SASR-				
4	*See* N-87-13362			12:25725
13	*See* N-87-16720			12:26034
SCIENTIFIC-				
2	*See* AD-A-176227/7/XAB			12:26020
3	*See* AD-A-176284/8/XAB			12:26021
SERI/CP-				
233-2959	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99: DE87006421	MN -61G	12:24708
SERI/SP-				
231-2550	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99: DE86010739	MN -61C	12:24718
231-3071	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87001149	MN -61	12:24719
SERI/STR-				
217-3002	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87001135	MN -60	12:24765
217-3050	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87001139	MN -60	12:24766
SERI/TP-				
217-3070	NTIS, PC A02; 3	DE87001130	MN -60	12:24767
SI-R-				
840129-1	NTIS (US Sales Only), PC A04; 3	DE87751693	MN -61E	12:24680
SLAC-PUB-				
3972	NTIS, PC A02; 3	DE87006583	MN -34D	12:26129
4223	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006779	MN -34D	12:26145
4239	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006780	MN -34D	12:26130
4240	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006781	MN -34D	12:26131
4241	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006782	MN -34D	12:26132
4242	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006783	MN -34D	12:26133
4243	NTIS, PC A02; 3	DE87006784	MN -34D	12:26134
4244	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006785	MN -34D	12:26135
4245	NTIS, PC A02; 3	DE87006786	MN -34D	12:26136
SR-				
86-R-5321-08	*See* PB-87-154019/XAB			12:25143
SSS-R-				
86-7726	*See* UCRL-15860-Vol.2	E 1.99: DE87006684	MN -11	12:25758
STF-				
15A85028	NTIS (US Sales Only), PC A02/MF A01	DE87751696	MN -95	12:25154
15A85046	NTIS (US Sales Only), PC A02; 3	DE87751686	MN -95d	12:25121
21A85015	NTIS (US Sales Only), PC A03/MF A01	DE87751694	MN -92	12:24534
21A85023	NTIS (US Sales Only), PC A02/MF A01; 1	DE87751700	MN -92	12:24535
21A85062	NTIS (US Sales Only), PC A02/MF A01; 1	DE87751695	MN -92	12:24536
25A85011	NTIS (US Sales Only), PC A05/MF A01; 1	DE87751697	MN -38	12:25506
45A85003	NTIS (US Sales Only), PC A04; 3	DE87751699	MN -95d	12:25122
60A85154	NTIS (US Sales Only), MF A01; 2	DE87751702	MN -97e	12:24691
TE-				
4326-98-86	*See* PB-87-153920/XAB			12:25118
TNO-HMT-				
85-071	NTIS (US Sales Only), PC A03/MF A01; 1	DE87751770	MN -90e	12:24490
85-0365A	Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands		ND -90i	12:24463
85-03657B	NTIS (US Sales Only), PC A03/MF A01; 1	DE87751766	MN -90i	12:24464
85-03657C	NTIS (US Sales Only), PC A04/MF A01; 1	DE87751767	MN -90i	12:24465
86-057	Hoofdgroep Maatschappelijke Technologie TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands		ND -90e	12:24491
TR-				
2	*See* AD-A-176215/2/XAB			12:25248
TR-EL-				
82-4/ 82-11.46	NTIS, PC A02/MF A01	TI86901603	MN -11	12:25849
TRW-AP-				
0923	*See* AD-A-175205/4/XAB			12:25448
TVA/ONRED/AWR-				
86/ 33	NTIS, PC A05/MF A01; 1	DE87900603	MN -11	12:25856
87/ 18	NTIS, PC A05/MF A01; 1	DE87900613	MN -11	12:25857
TVA/ONRED/LER-				
86/ 59	NTIS, PC A07/MF A01; 1	DE87900612	MN -11	12:24466
87/ 10	NTIS, PC A24/MF A01; 1 (GPO Dep.)	E 1.99: DE87007873	MN -61	12:24720

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TVA/ONRED/WRF-				
87/ 4	NTIS, PC A02/MF A01	DE87900618	MN -11	12:24692
87/ 5	NTIS, PC A02/MF A01	DE87900617	MN -11	12:24693
87/ 6	NTIS, PC A02/MF A01; 1	DE87900619	MN -90i	12:24779
TVA/OP/CEM-				
87/ 53	NTIS MF A01; 2	DE87900616	MN -98G	12:24899
TVA/OP/EDT-				
87/ 17	NTIS MF A01; 2	DE87900615	MN -96	12:25176
TVA/OP/EUDR-				
87/ 1	NTIS MF A01; 2	DE87900614	MN -98E	12:24942
TVA/OP/OPS-				
87/ 1	NTIS MF A01; 2	DE87900623	MN -98E	12:24769
87/ 2	NTIS, PC A02/MF A01; 1	DE87900611	MN -97	12:24791
TVA/PE/PE/INFO-				
86/ 18-Vol.2	NTIS, PC A04; 3	DE87900620	MN -98E	12:24943
U.OF-IOWA-				
86-15	*See* AD-A-175774/9/XAB			12:26056
UCB/ERL-M-				
86/ 94	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008194	MN -20g	12:26295
87/ 14	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008193	MN -20g	12:26296
UCID-				
20907	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008337	MN -25	12:25302
20951	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008342	MN -90c	12:24420
20977	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008339	MN -41	12:25986
20998	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87007520	MN -20	12:26346
21012	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007519	MN -38	12:25757
21033	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008341	MN -20a	12:26297
21034	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008340	MN -13	12:25183
UCLA-ENG-				
86-44	*See* DOE/ER/52123-1	E 1.99: DE87007965	MN -20	12:26329
UCLDE-DP-				
86-02	British Library, Document Supply Centre, Boston Spa, Wetherby, West Yorks LS23 6BQ		ND -61E	12:24682
UCRL-				
15341-82-84	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008167	MN -25	12:25303
15712	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008164	MN -21	12:25453
15829	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008160	MN -21	12:25266
15860-Vol.2	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87006684	MN -11	12:25758
15867-Vol.2	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87006723	MN -21	12:25454
15878	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE87008165	MN -21	12:25455
15879	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87006724	MN -38	12:25456
15884	NTIS MF A01; 2 (GPO Dep.)	E 1.99: DE87007060	MN -38	12:25485
15891	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008163	MN -21	12:25457
15895	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008161	MN -21	12:25267
15896-Rev.	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87008162	MN -21	12:25268
15900	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE87008485	MN -21	12:26347
53771	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006588	STD -38	12:25480
91913	NTIS, PC A02; 3	DE87007057	MN -34A	12:26083
92437	NTIS, PC A03; 3	DE87008159	MN -35	12:25759
93407	NTIS, PC A02; 3	DE87008152	MN -32	12:26392
94113	NTIS, PC A02; 3	DE87008151	MN -32	12:26393
94614	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE87007332	MN -11	12:24889
94926	NTIS, PC A02; 3	DE87007092	MN -34A	12:26084
95133	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87006828	MN -32	12:26410
95470	NTIS, PC A02/MF A01	DE87000885	MN -41	12:26001
95555	NTIS, PC A02; 3	DE87006820	MN -38	12:25752
95644	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE87003241	MN -96	12:25180
95861	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE87007445	MN -4	12:25362
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Minneapolis, MN 55455
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Documents Department
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Documents Division
Missoula, MT 59812
(406) 243-6700

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(402) 471-2045
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Santa Fe, NM 87501
(505) 827-2033, ext. 22

NEW YORK STATE LIBRARY
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Albany, NY 12230
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Wilson Library
BA/SS Documents Division
Chapel Hill, NC 27515
(919) 962-1321

UNIVERSITY OF NORTH DAKOTA
Chester Fritz Library
Documents Department
Grand Forks, ND 58202
(701) 777-2617, ext. 27
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Documents Department
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Columbus, OH 43215
(614) 462-7051

OKLAHOMA DEPT. OF LIBRARIES
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Oklahoma City, OK 73105
(405) 521-2502

OKLAHOMA STATE UNIV. LIB.
Documents Department
Stillwater, OK 74078
(405) 624-6546

PORTLAND STATE UNIV. LIB.
Documents Department
P.O. Box 1151
Portland, OR 97207
(503) 229-3673

STATE LIBRARY OF PENN.
Government Pub. Section
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Harrisburg, PA 17105
(717) 787-3752

TEXAS STATE LIBRARY
Public Services Department
P.O. Box 12927-Cap. Sta.
Austin, TX 78753
(512) 471-2996

TEXAS TECH. UNIV. LIBRARY
Govt. Documents Department
Lubbock, TX 79409
(806) 742-2268

UTAH STATE UNIVERSITY
Merrill Library, U.M.C. 30
Logan, UT 84322
(801) 750-2682

UNIVERSITY OF VIRGINIA
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Charlottesville, VA 22901
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WASHINGTON STATE LIBRARY
Documents Section
Olympia, WA 98504
(206) 753-4027

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Documents Department
Morgantown, WV 26506
(304) 293-3640

MILWAUKEE PUBLIC LIBRARY
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Milwaukee, WI 53233
(414) 278-3000

ST. HIST. LIB. OF WISCONSIN
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Madison, WI 53706
(608) 262-4347

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